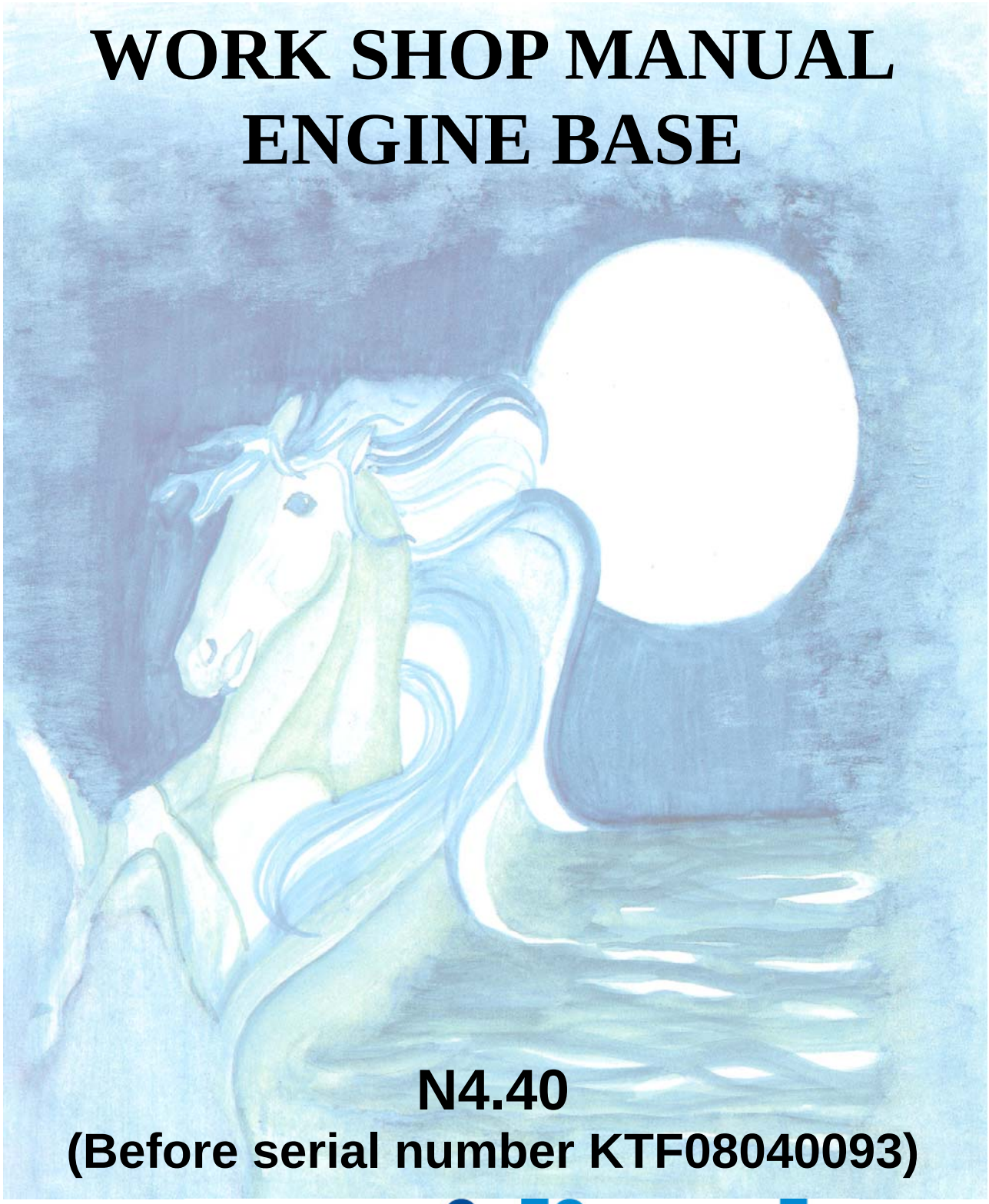
WORK SHOP MANUAL
ENGINE BASE



N4.40
(Before serial number KTF08040093)

nanni diesel

energy in blue

NANNI INDUSTRIES S.A.S – Zone Industrielle
11 avenue MARIOTTE
B.P.107 – 33260 LA TESTE - FRANCE

60300208

TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of 03-E2B series. It is divided into three parts, “General”, “Mechanism” and “Servicing”.

■ **General**

Information on the engine identification, the general precautions, maintenance check list, check and maintenance and special tools are described.

■ **Mechanism**

Information on the construction and function are included. This part should be understood before proceeding with troubleshooting, disassembling and servicing.

Refer to Diesel Engine Mechanism Workshop Manual (Code No. 9Y021-01870) for the one which has not been described to this workshop manual.

■ **Servicing**

Information on the troubleshooting, servicing specification lists, tightening torque, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information illustrations and specifications contained in this manual are based on the latest product information available at the time of publication.

The right is reserved to make changes in all information at any time without notice.

Do to covering many models of this manual, information or picture being used have not been specified as one model.

May 2004

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SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.

It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

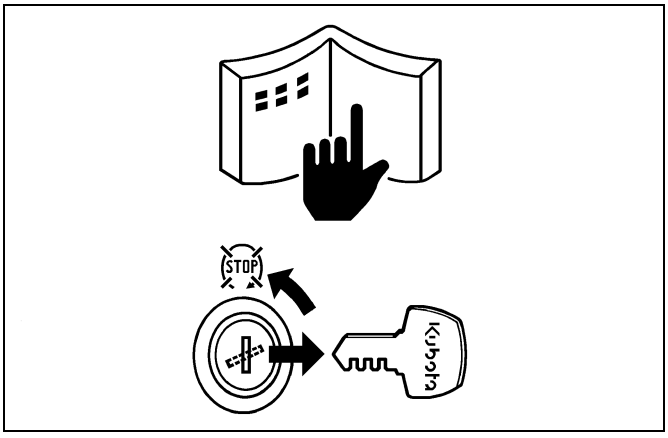
DANGER : Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING : Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION : Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

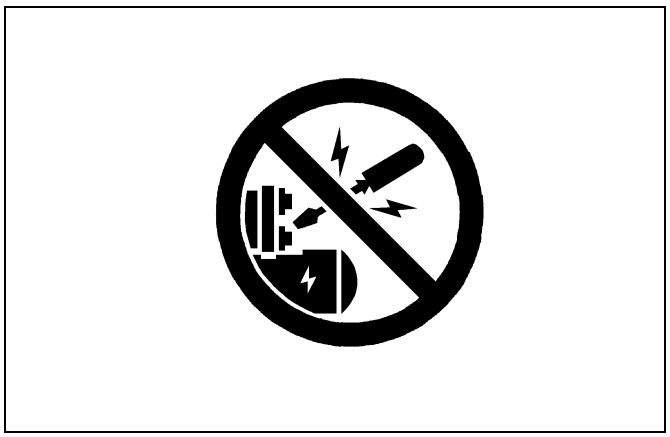
■ IMPORTANT : Indicates that equipment or property damage could result if instructions are not followed.

■ NOTE : Gives helpful information.



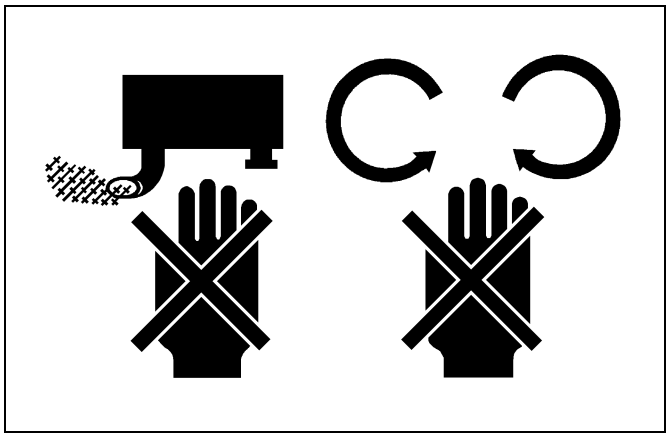
BEFORE SERVICING AND REPAIRING

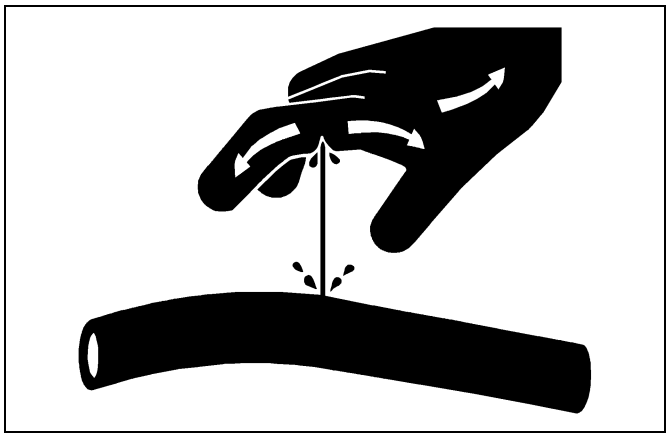
- Read all instructions and safety instructions in this manual and on your engine safety decals.
- Clean the work area and engine.
- Park the machine on a firm and level ground.
- Allow the engine to cool before proceeding.
- Stop the engine, and remove the key.
- Disconnect the battery negative cable.
- Hang a "**DO NOT OPERATE**" tag in operator station.



SAFETY STARTING

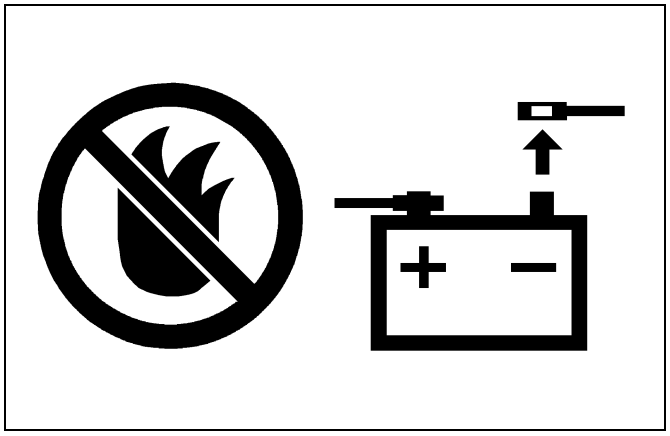
- Do not start the engine by shorting across starter terminals or bypassing the safety start switch.
- Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.





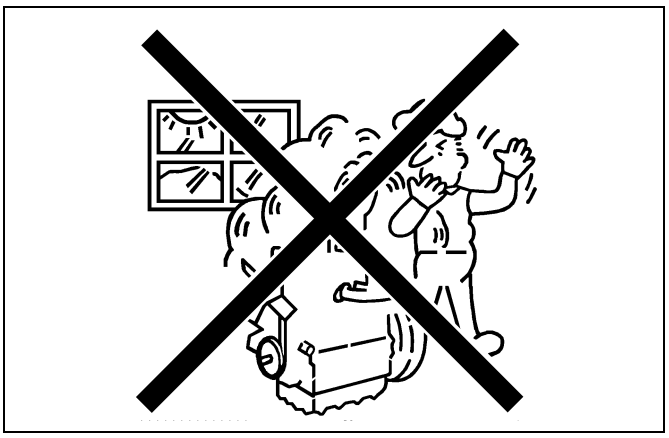
SAFETY WORKING

- Do not work on the machine while under the influence of alcohol, medication, or other substances or while fatigued.
- Wear close fitting clothing and safety equipment appropriate to the job.
- Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Do not touch the rotating or hot parts while the engine is running.
- Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Only remove radiator cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve pressure before removing completely.
- Escaping fluid (fuel or hydraulic oil) under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or fuel lines. Tighten all connections before applying pressure.
- Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



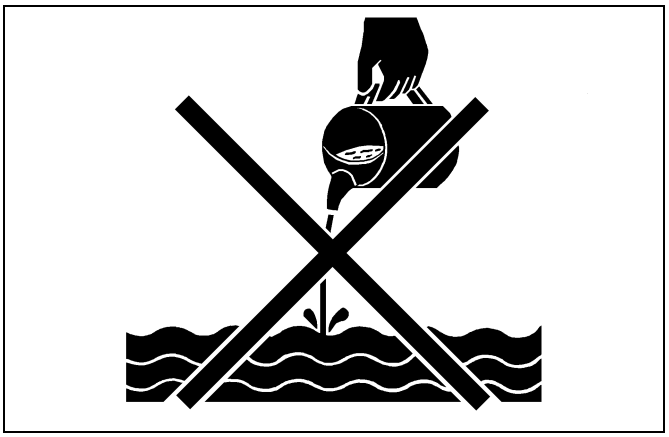
AVOID FIRES

- Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
- To avoid sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
- Make sure that no fuel has been spilled on the engine.



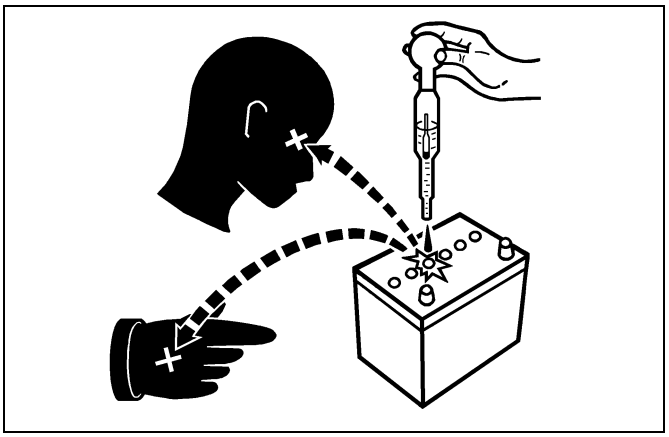
VENTILATE WORK AREA

- If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.



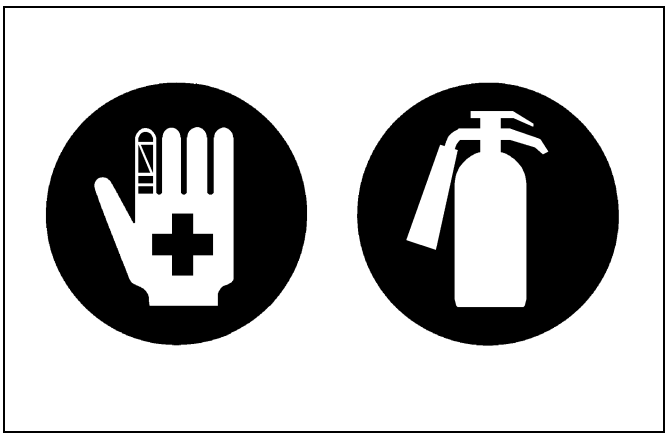
DISPOSE OF FLUIDS PROPERLY

- Do not pour fluids into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, electrolyte and other harmful waste.



PREVENT ACID BURNS

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.



PREPARE FOR EMERGENCIES

- Keep a first aid kit and fire extinguisher handy at all times.
- Keep emergency numbers for doctors, ambulance service, hospital and fire department near your telephone.

TECHNICAL DATA
ENGINE MODEL N4.40
(up to serial number: KTF08040092)

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ENGINE SPECIFICATIONS

Number of cylinders: 4
Displacement: 1857 cc
Bore - Stroke: 80 X 92.4 mm
Compression ratio: 23/1
Max. pressure difference between cyl. : 10%
Compression pressure: 36 to 38 bars
Maximum speed without load: 3050 rpm
Maximum speed in load: 2800 rpm
Idle speed in forward gear: 850 rpm
Max. Torque:
Firing order: 1 - 3 - 4 - 2
Rotation: Anti clockwise (Flywheel)

INJECTION

Type of injector: BOSCH JET
Fuel injection pressure: 140 to 150 MPa
Injection pump manufacturer:
BOSCH PFR4M
Injection timing: 18° before TDC

TIGHTENING TORQUE

Arm head cover cap nuts: 6.9 to 8.8 Nm
Cylinder head bolts: M11 93 to 98 Nm
Flywheel bolts: M12 98 to 107 Nm
Connecting rod bolts: with coll.: 38 Nm
Without coll.: 48 Nm
Rocker arm bracket nuts: 26 Nm
Main bearing caps bolts: 46 to 50 Nm
Main bearing caps bolts: 68 to 73 Nm
Nozzle holder assembly: 50 Nm to 68 Nm
Glow Plug : 22 Nm

LUBRIFICATION

Oil pressure at idle RPM: 1 bar
Oil pressure at maximum load: 3 to 4.5 b
Recommended oil: 15W 40API CD
Oil pan capacity: 9.5 litres
Gearbox model:
Oil capacity: } depending on type
Recommended oil:

DIAGRAMS

Valve clearance (cold):
Inlet: 0.18 to 0.20 mm
Exhaust: 0.18 to 0.20 mm
Valve recessing: + 0.05 to - 0.15 mm

PISTON RINGS

Piston ring gap:
Piston top compression: 0.30 to 0.45 mm
Intermediate: 0.30 to 0.45 mm
Oil control: 0.25 to 0.45 mm

CYLINDER HEAD

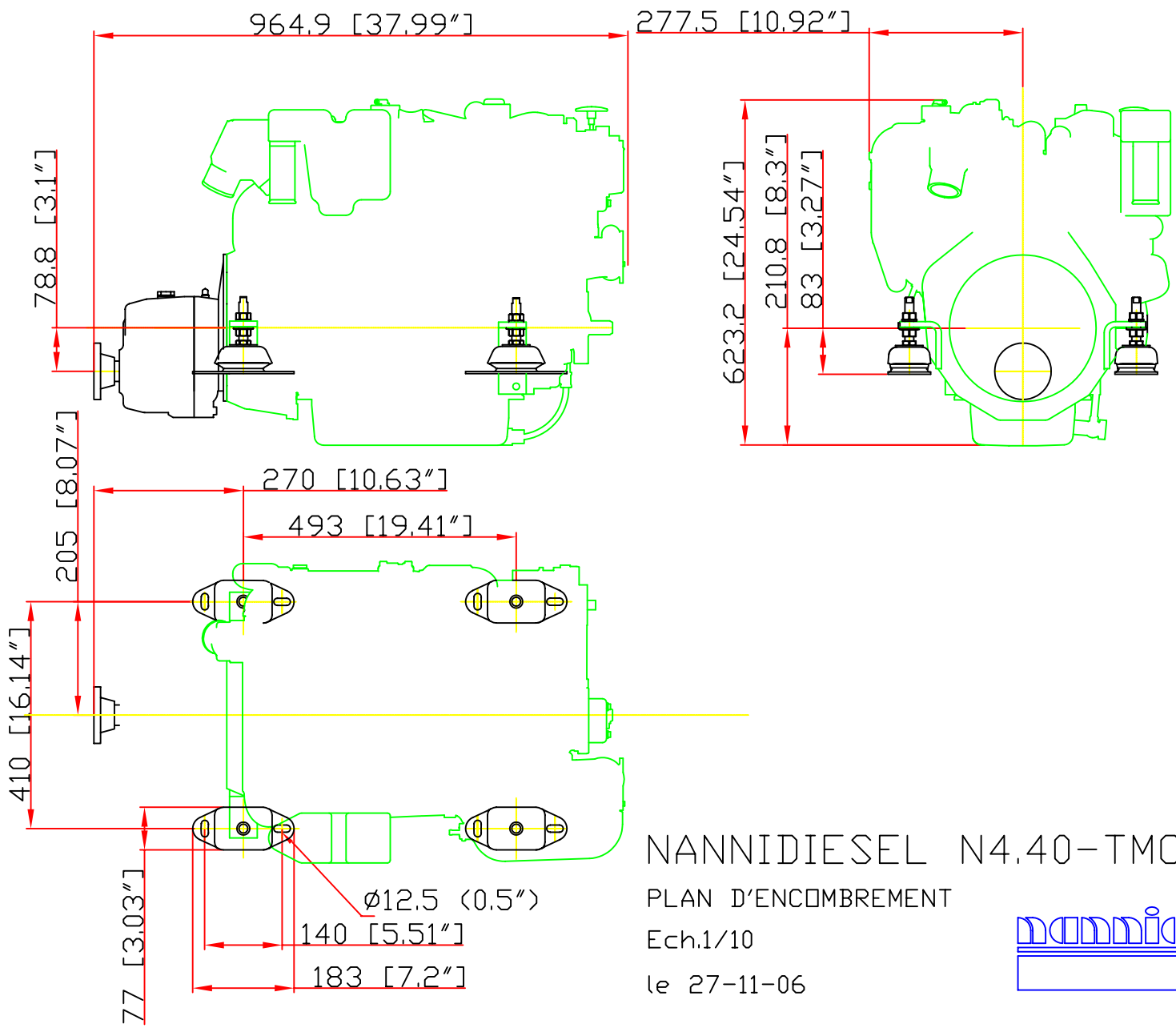
Cylinder head surface flatness: 0.05 mm

SEA WATER PUMP

Water flow: 33 litres per minutes

GLOW PLUGS

Resistance : 0.8 ohms



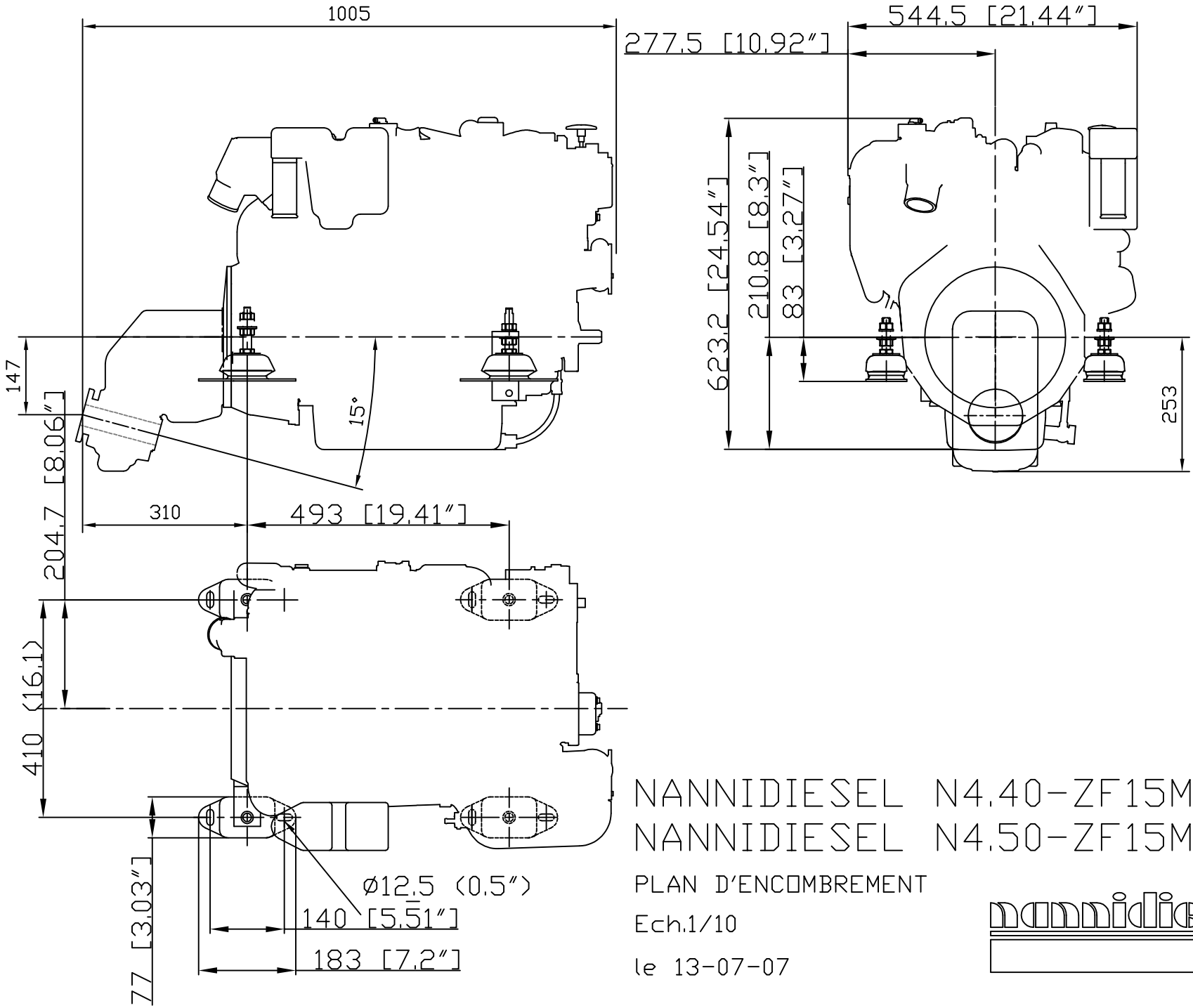
NANNIDIESEL N4.40-TMC60

PLAN D'ENCOMBREMENT

Ech.1/10

le 27-11-06

nannidiesel



NANNIDIESEL N4.40-ZF15MIV
NANNIDIESEL N4.50-ZF15MIV

PLAN D'ENCOMBREMENT

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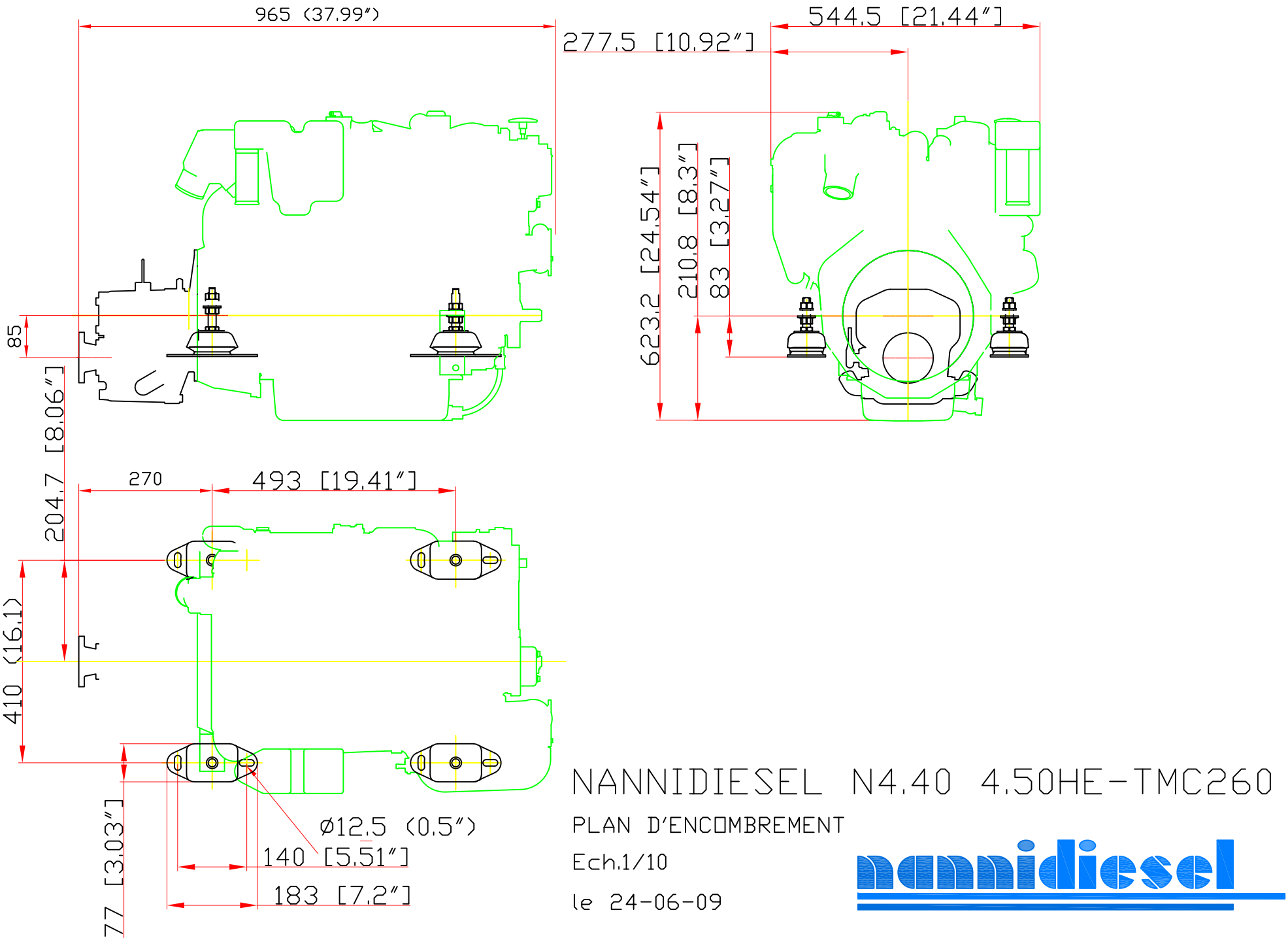
nannidiesel



NANNIDIESEL N4.40 4.50HE-TMC260

PLAN D'ENCOMBREMENT

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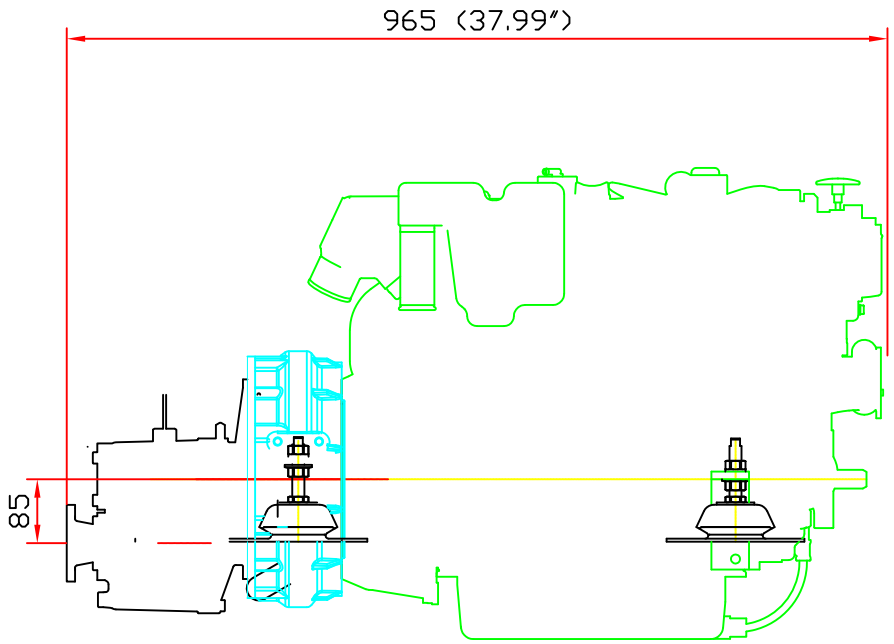

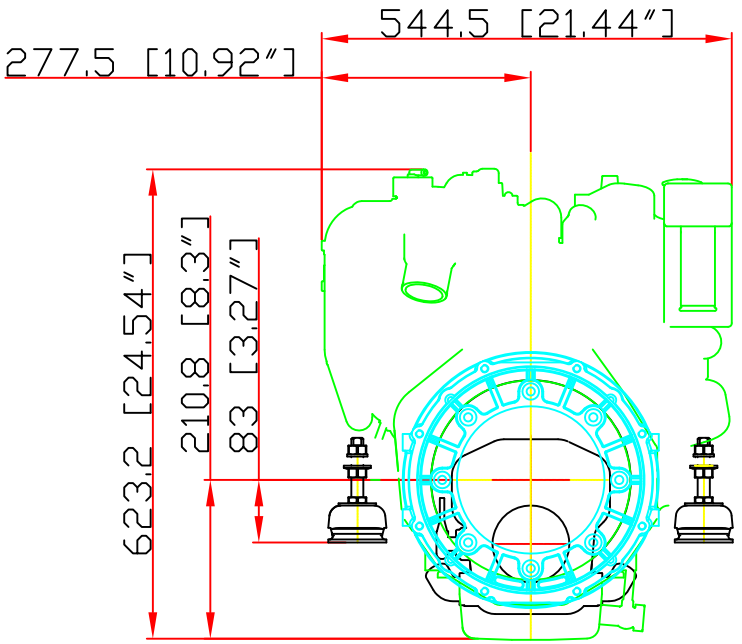

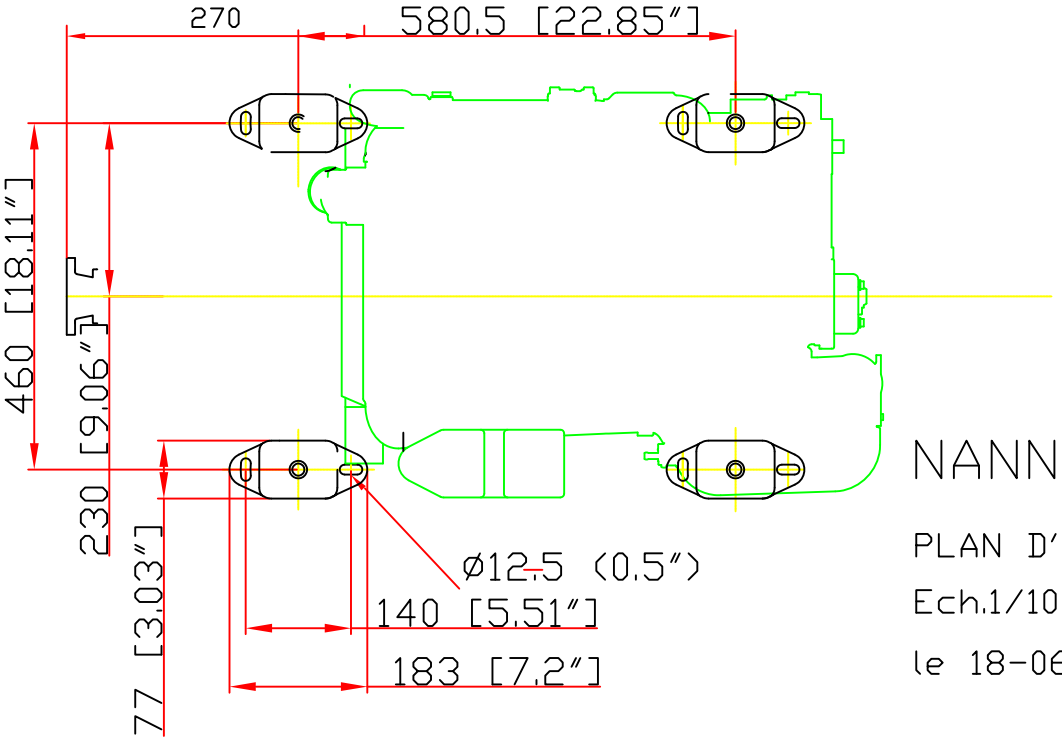

NANNIDIESEL N4.40/50-GI TMC260

PLAN D'ENCOMBREMENT

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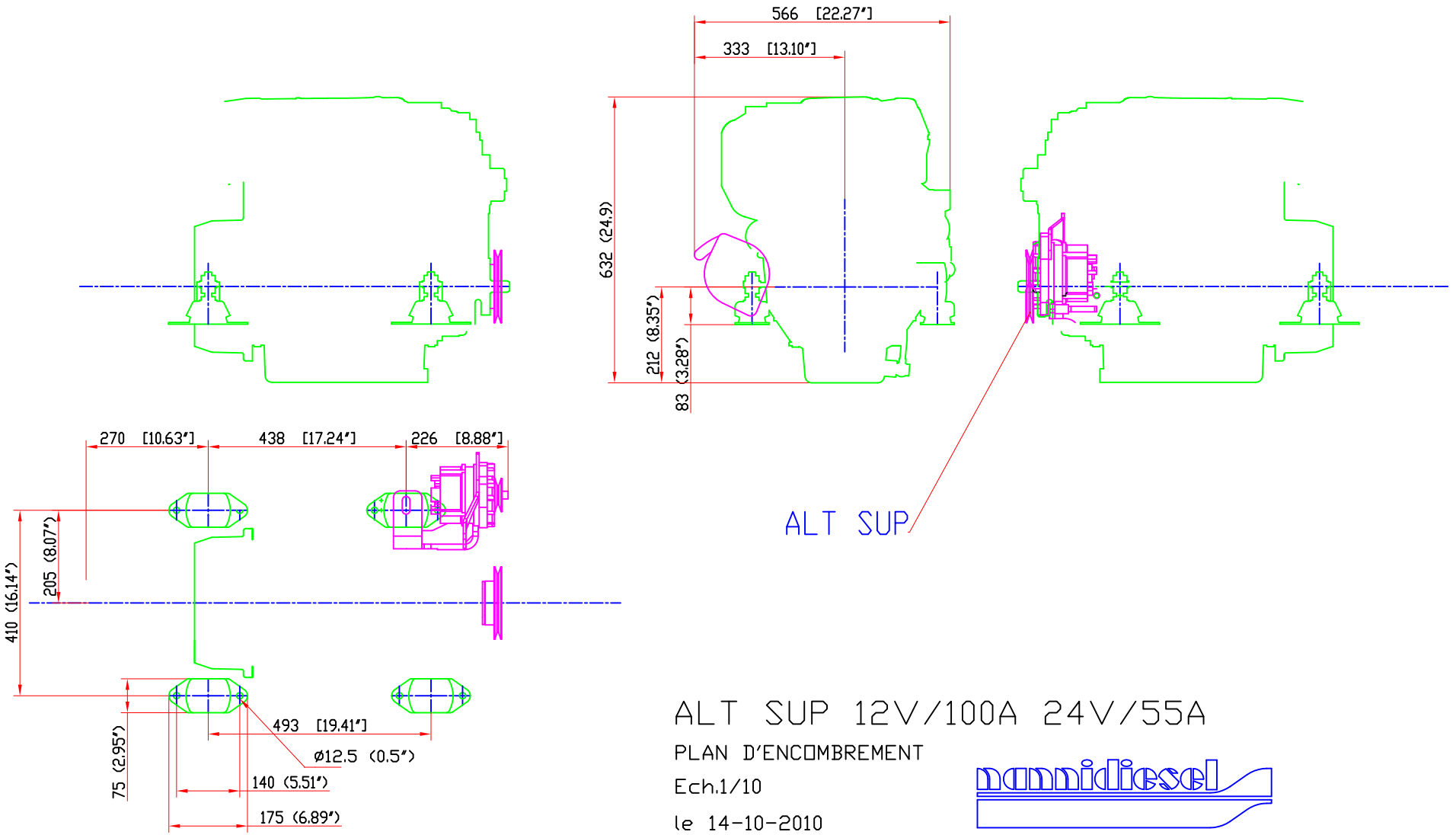
nannidiesel



ALT SUP 12V/100A 24V/55A

PLAN D'ENCOMBREMENT

Ech.1/10

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nanni diesel

GENERAL

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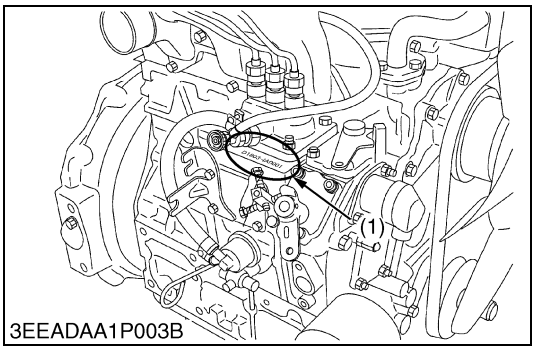
1. ENGINE IDENTIFICATION

[1] MODEL NAME AND ENGINE SERIAL NUMBER



When contacting the manufacture, always specify your engine model name and serial number.

The engine model and its serial number need to be identified before the engine can be serviced or parts replaced.

■ Engine Serial Number

The engine serial number is an identified number for the engine. It is marked after the engine model number.

It indicates month and year of manufacture as follows.

- **Year of manufacture**

Alphabet or Number	Year	Alphabet or Number	Year
1	2001	F	2015
2	2002	G	2016
3	2003	H	2017
4	2004	J	2018
5	2005	K	2019
6	2006	L	2020
7	2007	M	2021
8	2008	N	2022
9	2009	P	2023
A	2010	R	2024
B	2011	S	2025
C	2012	T	2026
D	2013	V	2027
E	2014		

(1) Engine Model Name and Serial Number

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- **Month of manufacture**

Month	Engine Serial Number	
	0001 ~ 9999	10000 ~
January	A0001 ~ A9999	B0001 ~
February	C0001 ~ C9999	D0001 ~
March	E0001 ~ E9999	F0001 ~
April	G0001 ~ G9999	H0001 ~
May	J0001 ~ J9999	K0001 ~
June	L0001 ~ L9999	M0001 ~
July	N0001 ~ N9999	P0001 ~
August	Q0001 ~ Q9999	R0001 ~
September	S0001 ~ S9999	T0001 ~
October	U0001 ~ U9999	V0001 ~
November	W0001 ~ W9999	X0001 ~
December	Y0001 ~ Y9999	Z0001 ~

e.g. D1703-4A0001

“4” indicates 2004 and “A” indicates January.

So, 4A indicates that the engine was manufactured in January, 2004.

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[2] E2B ENGINE

[ex. Model Name D1703-**E2B**-XXXX]

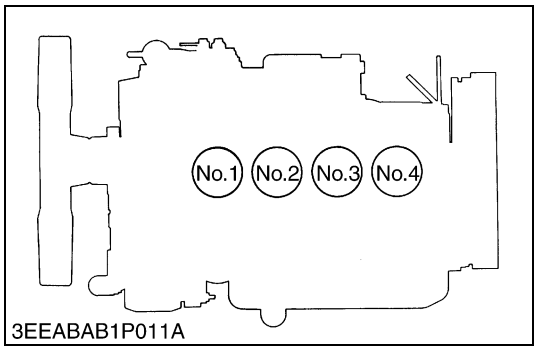
The emission controls that have been put into effect in various countries to prevent air pollution will be stepped up. The time to enforce the regulations differs depending on the engine output classifications.

Kubota has been supplying the diesel engines conforming to the emission regulations in respective countries. Exhaust emissions regulations shift to the second stage. Kubota executed the improvement of the engine according to this regulation.

In order to discriminate the engines conforming to Tier 1 / Phase 1 requirements and those conforming to Tier 2 / Phase 2 requirements, we have adopted E2B as a new model name for the engines conforming Tier 2 / Phase 2 regulations.

In the after-sale services for 03-E2B series engines, only use the dedicated parts for E2B models and carry out the maintenance services accordingly.

[3] CYLINDER NUMBER



The cylinder numbers of KUBOTA diesel engine are designated as shown in the figure.

The sequence of cylinder numbers is given as No.1, No.2, No.3 and No.4 starting from the gear case side.

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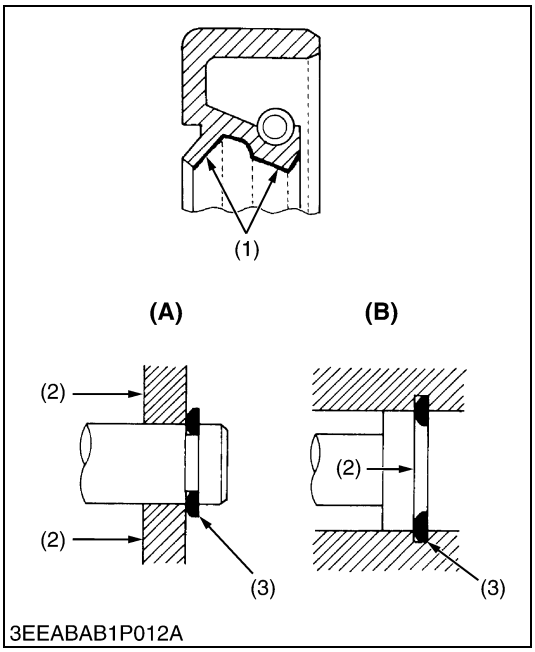
2. GENERAL PRECAUTIONS



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- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.
- When special tools are required, use KUBOTA genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only KUBOTA genuine parts for parts replacement to maintain engine performance and to ensure safety.
- Gaskets and O-rings must be replaced during reassembly. Apply grease to new O-rings or oil seals before assembling.
- When reassembling external or internal snap rings, position them so that the sharp edge faces against the direction from which force is applied.
- Be sure to perform run-in the serviced or reassembled engine. Do not attempt to give heavy load at once, or serious damage may result to the engine.

(1) Grease
(2) Force
(3) Place the Sharp Edge against the Direction of Force

(A) External Snap Ring
(B) Internal Snap Ring

W1011734

3. MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

Item		Service Interval Every											
		50 hrs	100 hrs	150 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
* Checking fuel hoses and clamp bands		☆											
Changing engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm, 3.54 in.)	★		☆									
	(2) Oil pan depth (124 mm, 4.88 in.)	★			☆								
*Cleaning air cleaner element (replace the element after 6-times cleanings)			☆										
Cleaning fuel filter (Element type)			☆										
Checking battery electrolyte level			☆										
Checking fan belt tension and damage			☆										
Replacing oil filter cartridge	(1) Oil pan depth (90 mm, 3.54 in.)	★		☆									
	(2) Oil pan depth (124 mm, 4.88 in.)	★			☆								
Checking radiator hoses and clamp bands					☆								
* Checking intake air line					☆								
* Replacing fuel filter						☆							
Cleaning water jacket and radiator interior							☆						
Replacing fan belt							☆						
Recharging battery								☆					
* Replacing air cleaner element									☆				
Checking valve clearance										☆			
* Checking injection nozzle pressure											☆		
* Checking turbocharger												☆	
* Checking injection timing												☆	
* Checking injection pump												☆	
* Replacing intake air line													☆
Replacing battery													☆
Replacing radiator hoses and clamp bands													☆
* Replacing fuel hoses and clamps													☆
Changing radiator coolant (L.L.C.)													☆

★ Change engine oil and replace oil filter cartridge after the first 50 hours of operation.

* The items listed above (* marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.

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CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

■ NOTE

Lubricating Oil

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

Fuel / Lubricating oil class	Low sulfur (0.5 % ≥)	High sulfur	Remarks
CF	❍	❍	TBN ≥ 10
CF-4	❍	X	
CG-4	❍	X	

❍ : Recommendable X : Not recommendable

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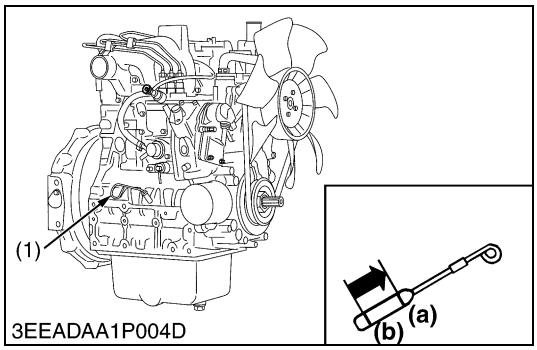
4. CHECK AND MAINTENANCE

[1] DAILY CHECK POINTS



Checking Engine Oil Level

1. Level the engine.
2. To check the oil level, draw out the dipstick (1), wipe it clean, reinsert it, and draw it out again.
   Check to see that the oil level lies between the two notches.
3. If the level is too low, add new oil to the specified level.

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous, drain old oil. Never mix two different types of oil.**

■ **NOTE**

- **Be sure to inspect the engine, locating it on a horizontal place. If placed on gradients, accurately, oil quantity may not be measured.**
- **Be sure to keep the oil level between upper and lower limits of the dipstick. Too much oil may cause a drop in output or excessive blow-by gas. On the closed breather type engine in which mist is sucked through port, too much oil may caused oil hammer. While too little oil, may seize the engine's rotating and sliding parts.**

(1) Dipstick

(a) Maximum
(b) Minimum

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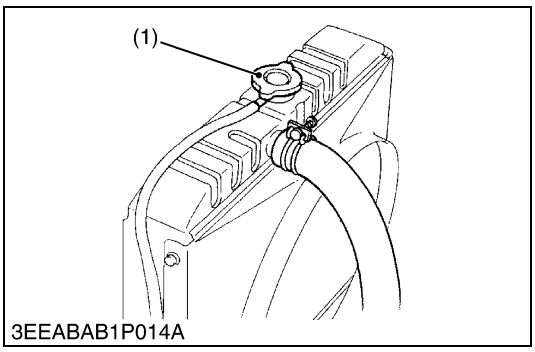

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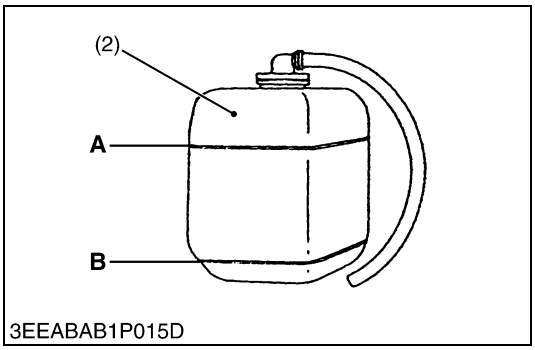

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Checking and Replenish Coolant

1. Without recovery tank :
   Remove the radiator cap (1) and check to see that the coolant level is just below the port.
   With recovery tank (2) :
   Check to see that the coolant level lies between **FULL** (**A**) and **LOW** (**B**).
2. If coolant level is too low, check the reason for decreasing coolant.
   (Case 1)
   If coolant is decreasing by evaporation, replenish only fresh, soft water.
   (Case 2)
   If coolant is decreasing by leak, replenish coolant of the same manufacture and type in the specified mixture ratio (fresh, soft water and L.L.C.). If the coolant brand cannot be identified, drain out all of the remaining coolant and refill with a totally new brand of coolant mix.

CAUTION

- **Do not remove the radiator cap until coolant temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.**

IMPORTANT

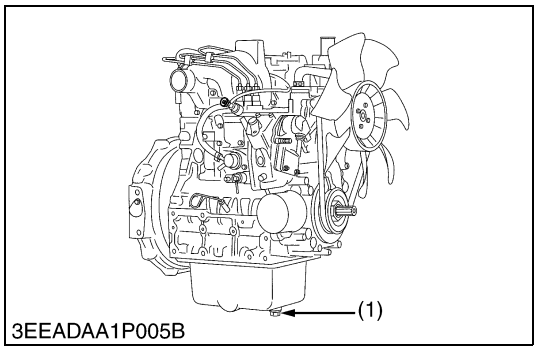
- **During filling the coolant, air must be vented from the engine coolant passages. The air vents by jiggling the radiator upper and lower hoses.**
- **Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and the engine could overheat.**
- **Do not use an antifreeze and scale inhibitor at the same time.**
- **Never mix the different type or brand of L.L.C..**

(1) Radiator Cap
(2) Recovery Tank

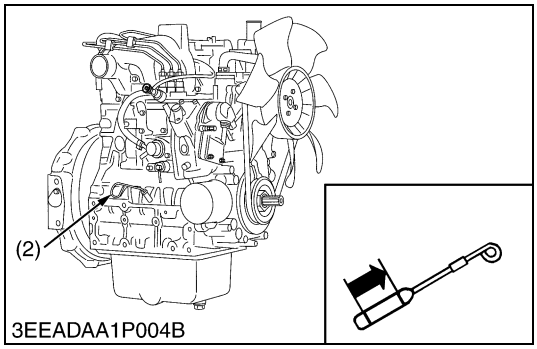
A: FULL
B: LOW

W1035779

[2] CHECK POINTS OF INITIAL 50 HOURS



3EEADAA1P005B



3EEADAA1P004B

Changing Engine Oil

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

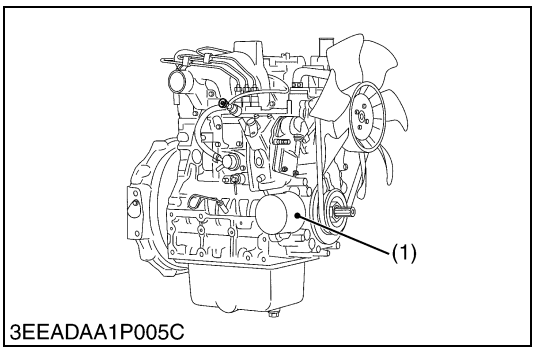
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
D1403-E2B D1503-E2B D1703-E2B	7.0 L 1.85 U.S.gals	5.6 L 1.48 U.S.gals
V1903-E2B V2203-E2B	9.5 L 2.51 U.S.gals	7.6 L 2.01 U.S.gals
V2003-TE2B	9.8 L 2.59 U.S.gals	7.9 L 2.09 U.S.gals
F2803-E2B	12.0 L 3.17 U.S.gals	–

*90 mm (3.54 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1016604



3EEADAA1P005C

Replacing Oil Filter Cartridge

CAUTION

- **Be sure to stop the engine before replacing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

IMPORTANT

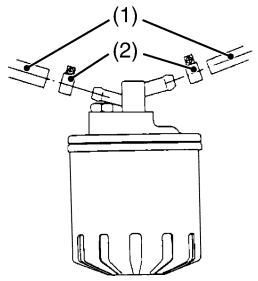
- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

(1) Engine Oil Filter Cartridge

W1013487

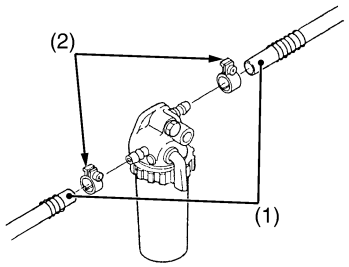
[3] CHECK POINTS OF EVERY 50 HOURS

[A]



3EEACAA1P057D

[B]



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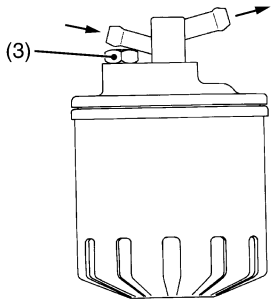
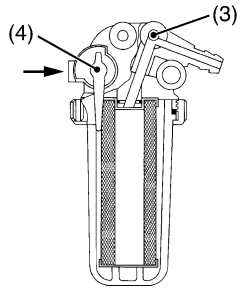
[A]



3EEACAA1P059A

[B]



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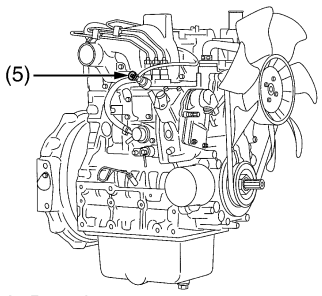

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Checking Fuel Hoses and Clamp Bands

1. If the clamp (2) is loose, apply oil to the threads and securely retighten it.
2. The fuel hose (1) is made of rubber and ages regardless of the period service.
   Change the fuel hose together with the clamp every two years.
3. However, if the fuel hose and clamp are found to be damaged or deteriorate earlier than two years, then change or remedy.
4. After the fuel hose and the clamp have been changed, bleed the fuel system.

CAUTION

- **Stop the engine when attempting the check and change prescribed above.**

(When bleeding fuel system)

1. Fill the tank with fuel and open the fuel cock (4). (**[B]** only)
2. Loosen the air vent plug (3) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent cock (5) on top of the fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key to **AC** position and pump the fuel up for 10 to 15 seconds.
   If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent cock after air bleeding.

NOTE

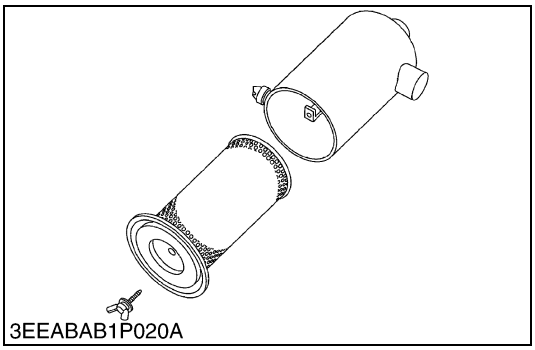
- **Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.**

(1) Fuel Hose
(2) Clamp
(3) Air Vent Plug
(4) Fuel Cock
(5) Air Vent Cock

[A] Cartridge Type
[B] Element Type

W1035921

[4] CHECK POINTS OF EVERY 100 HOURS


3EEABAB1P020A

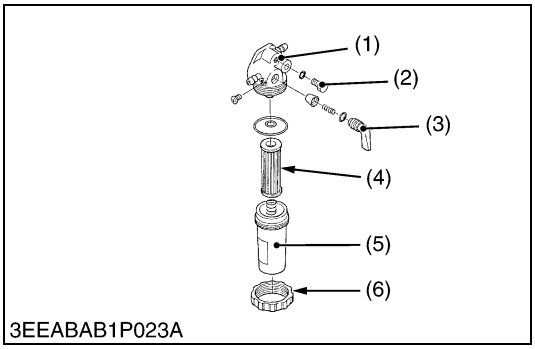
Cleaning Air Cleaner Element

1. Remove the air cleaner element.
2. Use clean dry compressed air on the inside of the element.
   Pressure of compressed air must be under 205 kPa (2.1 kgf/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

■ **NOTE**

- **The air cleaner uses a dry element. Never apply oil to it.**
- **Do not run the engine with filter element removed.**
- **Change the element once a year or every 6th cleaning.**

W1045746



3EEABAB1P023A

Cleaning Fuel Filter (Element Type only)

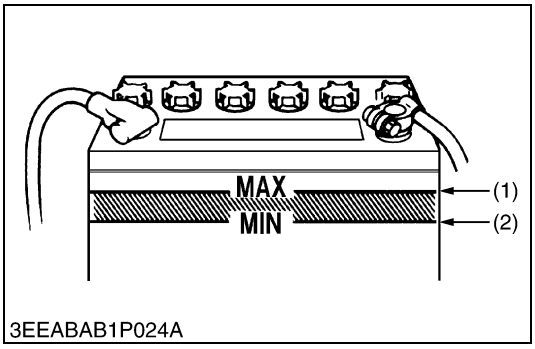
1. Close the fuel cock (3).
2. Unscrew the retaining ring (6) and remove the filter cup (5), and rinse the inside with kerosene.
3. Take out the element (4) and dip it in the kerosene to rinse.
4. After cleaning, reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

■ **IMPORTANT**

- **If dust and dirt enter the fuel, the fuel injection pump and injection nozzle will wear quickly. To prevent this, be sure to clean the fuel filter cup (5) periodically.**

(1) Cock Body
(2) Air Vent Plug
(3) Fuel Cock
(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

W1046058



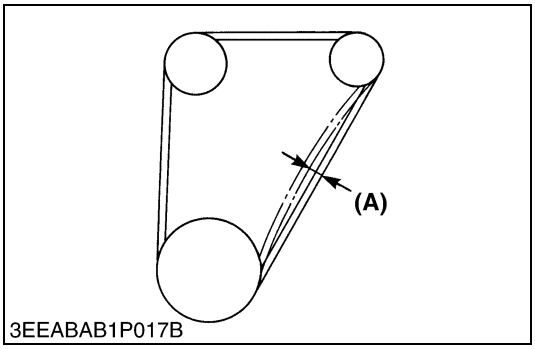
3EEABAB1P024A

Checking Battery Electrolyte Level

1. Check the battery electrolyte level.
2. If the level is below than lower level line (2), and the distilled water to pour level of each cell.

(1) Upper Level Line
(2) Lower Level Line

W1047154



3EEABAB1P017B

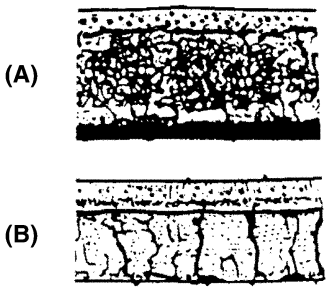
Fan Belt Tension

1. Measure the deflection **(A)**, depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection **(A)**	Factory spec.	7.0 to 9.0 mm 0.28 to 0.35 in.

(A) Deflection

W1208957



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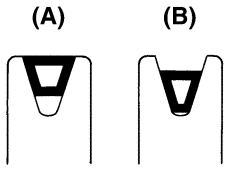


3EEABAB1P018A

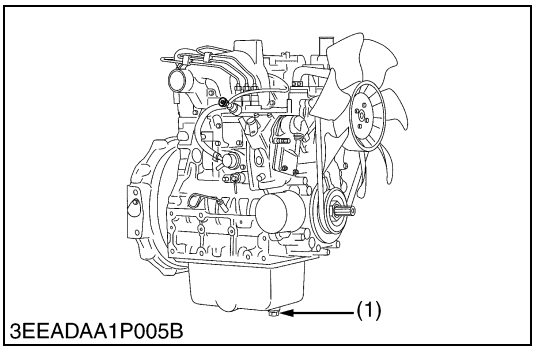
Fan Belt Damage and Wear

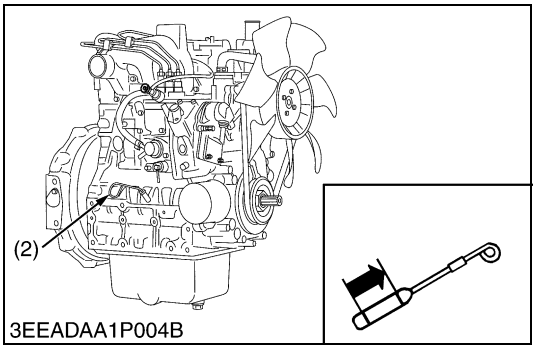
1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(A) Good **(B) Bad**

W1057475

[5] CHECK POINTS OF EVERY 150 HOURS





Changing Engine Oil (for 90 mm (3.54 in.) Depth Oil Pan)

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

IMPORTANT

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

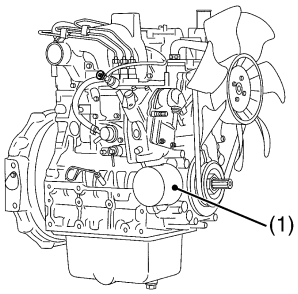
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
D1403-E2B D1503-E2B D1703-E2B	7.0 L 1.85 U.S.gals	5.6 L 1.48 U.S.gals
V1903-E2B V2203-E2B	9.5 L 2.51 U.S.gals	7.6 L 2.01 U.S.gals
V2003-TE2B	9.8 L 2.59 U.S.gals	7.9 L 2.09 U.S.gals
F2803-E2B	12.0 L 3.17 U.S.gals	–

*90 mm (3.54 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1016063



3EEADAA1P005C

Replacing Oil Filter Cartridge (for 90 mm (3.54 in.) Depth Oil Pan)

CAUTION

- **Be sure to stop the engine before replacing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

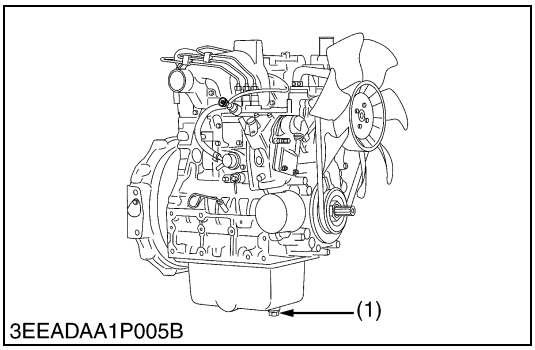
IMPORTANT

- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

(1) Engine Oil Filter Cartridge

W1016338

[6] CHECK POINTS OF EVERY 200 HOURS



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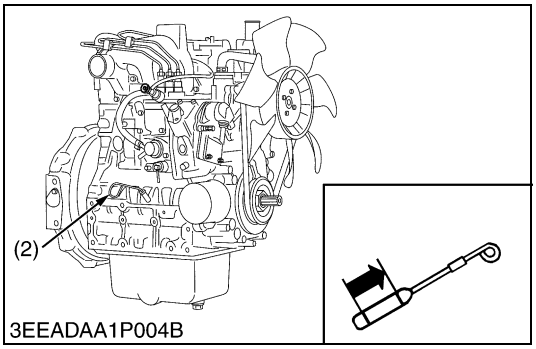


3EEADAA1P004B

Changing Engine Oil (for 124 mm (4.88 in.) Depth Oil Pan)

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

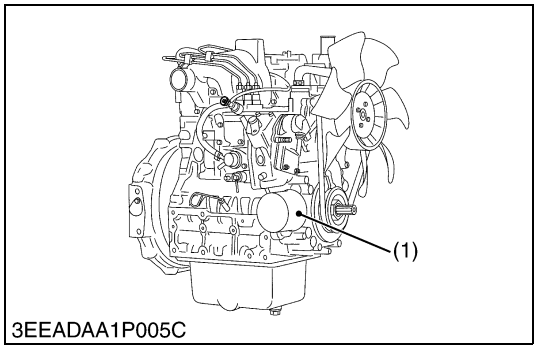
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.54 in.)
D1403-E2B D1503-E2B D1703-E2B	7.0 L 1.85 U.S.gals	5.6 L 1.48 U.S.gals
V1903-E2B V2203-E2B	9.5 L 2.51 U.S.gals	7.6 L 2.01 U.S.gals
V2003-TE2B	9.8 L 2.59 U.S.gals	7.9 L 2.09 U.S.gals
F2803-E2B	12.0 L 3.17 U.S.gals	–

*90 mm (3.54 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1016525



3EEADAA1P005C

Replacing Oil Filter Cartridge (for 124 mm (4.88 in.) Depth Oil Pan)

CAUTION

- **Be sure to stop the engine before replacing filter cartridge.**

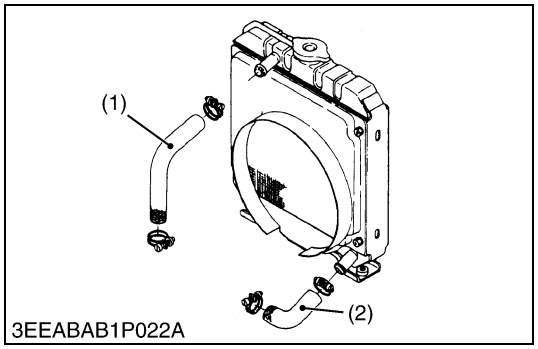
1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

IMPORTANT

- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

(1) Engine Oil Filter Cartridge

W1016800



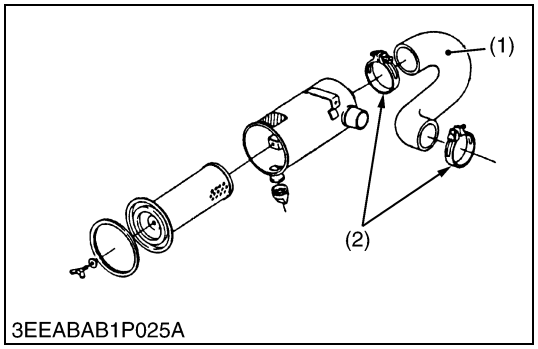
3EEABAB1P022A

Checking Radiator Hoses and Clamp Bands

1. Check to see if the radiator hoses are properly fixed every 200 hours of operation or every six months, whichever comes first.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The water hose is made of rubber and tends to age. It must be replaced every two years. Also replace the clamp and tighten it securely.

(1) Upper Hose (2) Lower Hose

W1029518



3EEABAB1P025A

Checking Intake Air Line

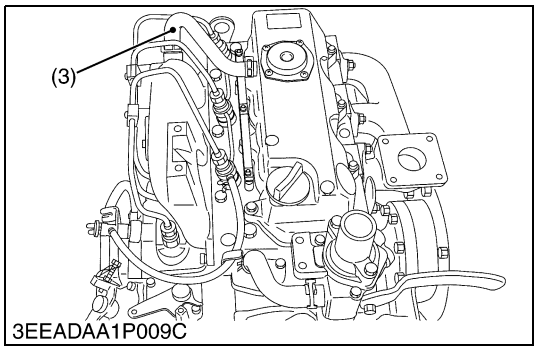
1. Check to see if the intake air hose(s) and the breather hose (3) are properly fixed every 200 hours of operation.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The intake air hose(s) and the breather hose are made of rubber and tends to age. It must be changed every two years. Also change the clamp and tighten it securely.

IMPORTANT

- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

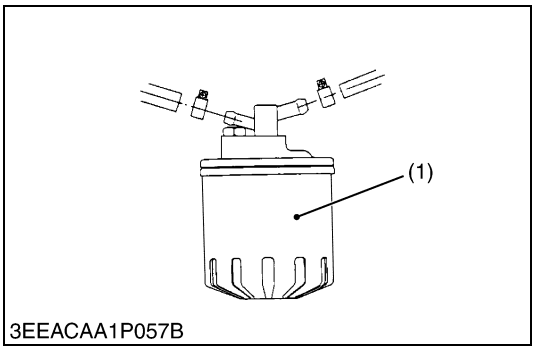
(1) Intake Air Hose (3) Breather Hose
(2) Clamp

W1029631



3EEADAA1P009C

[7] CHECK POINTS OF EVERY 400 HOURS



3EEACAA1P057B

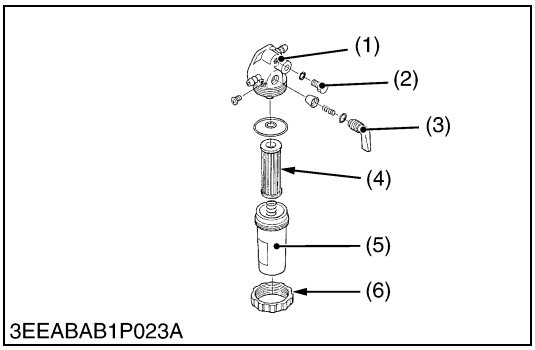
Replacing Fuel Filter Cartridge (Cartridge Type)

Water and dust in fuel are collected in the filter cartridge. So, change the filter cartridge every 400 hours service.

1. Remove the used filter cartridge with filter wrench.
2. Apply a thin film of fuel to the surface of new filter cartridge gasket before screwing on.
3. Then tighten enough by hand.
4. Loosen the air vent plug to let the air out.
5. Start engine and check for fuel leakage.

(1) Fuel Filter Cartridge

W1050548



3EEABAB1P023A

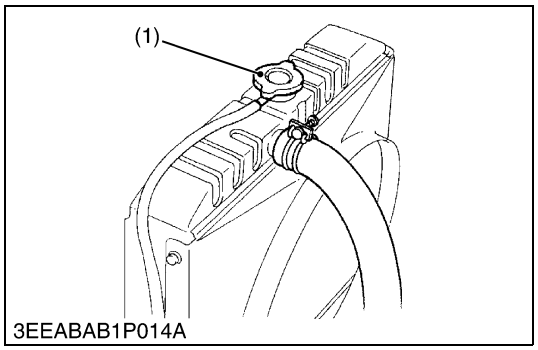
Replacing Fuel Filter Element (Element Type)

1. Close the fuel cock (3).
2. Unscrew the retaining ring (6) and remove the filter cup (5), and rinse the inside with kerosene.
3. Replace the filter element (4).
4. Reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

(1) Cock Body
(2) Air Vent Plug
(3) Fuel Cock
(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

W1050583

[8] CHECK POINTS OF EVERY 500 HOURS



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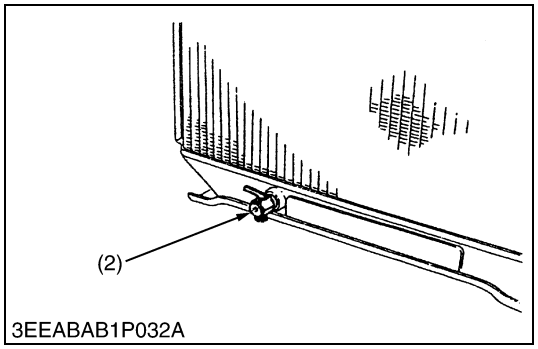

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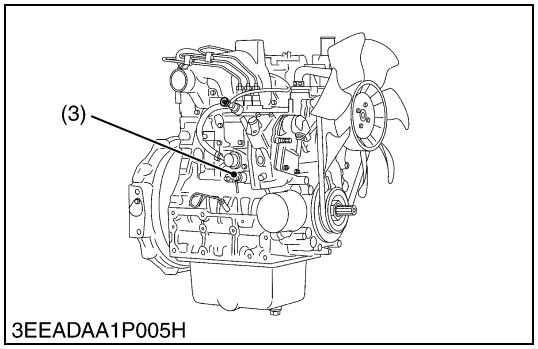

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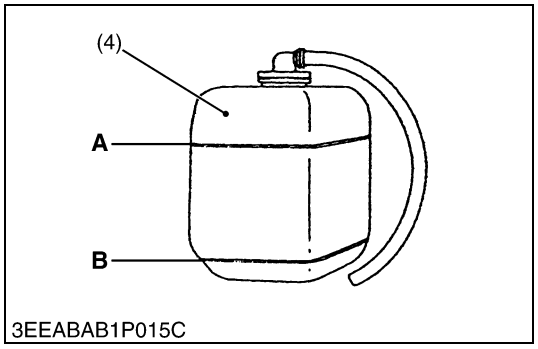

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Cleaning Water Jacket and Radiator Interior

CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Stop the engine and let cool down.
2. To drain the coolant, open the radiator drain plug (2) and remove the radiator cap (1). Then radiator cap (1) must be removed to completely drain the coolant. And open the drain cock (3).
3. After all coolant is drained, close the drain plug.
4. Fill with clean water and cooling system cleaner.
5. Follow directions of the cleaner instruction.
6. After flushing, fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap (1) securely.
7. Fill with coolant up to “FULL” (**A**) mark on the recovery tank (4).
8. Start and operate the engine for few minutes.
9. Stop the engine and let cool. Check coolant level of radiator and recovery tank (4) and add coolant if necessary.

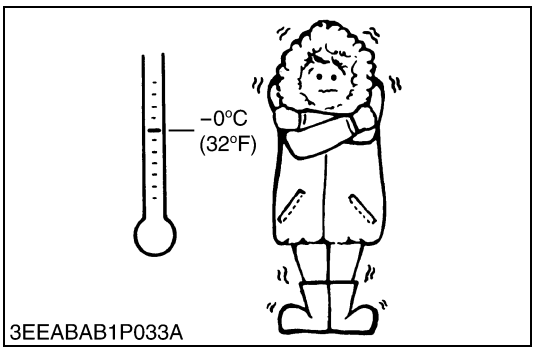
■ **IMPORTANT**

- **Do not start engine without coolant.**
- **Use clean, fresh, soft water and anti-freeze to fill the radiator and recovery tank.**
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**
- **Securely tighten radiator cap. If the cap is loose or improperly fitted, water may leak out and the engine could overheat.**

(1) Radiator Cap
(2) Drain Plug
(3) Drain Cock
(4) Recovery Tank

A : Full
B : Low

W1038102



Anti-Freeze

- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Before adding anti-freeze for the first time, clean the radiator interior by pouring fresh, soft water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Basically, it should be referred to SAE J1034 standard, more specifically also to SAE J814c.
- Mix the anti-freeze with fresh, soft water, and then fill into the radiator.

■ **IMPORTANT**

- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**

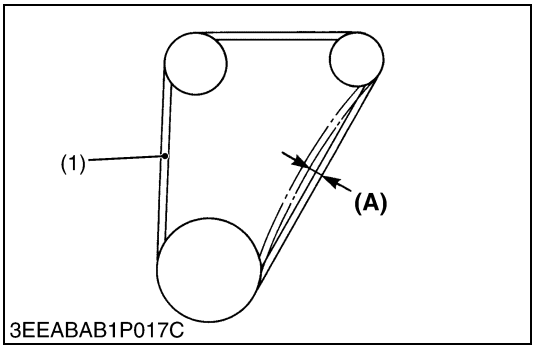
Vol % anti-freeze	Freezing point		Boiling point*	
	°C	°F	°C	°F
40	–24	–11.2	106	222.8
50	–37	–34.6	108	226.4

* At 1.013 × 100000 Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

■ **NOTE**

- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.**
- **When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and fresh, soft water in the specified mixing ratio.**
- **Anti-freeze absorbs moisture. Keep unused anti-freeze in a tightly sealed container.**
- **Do not use radiator cleaning agents when anti-freeze has been added to the coolant.**
  (Anti-freeze contains an anti-corrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine parts.)

W1039218



Replacing Fan Belt

1. Remove the alternator.
2. Remove the fan belt (1).
3. Replace new fan belt.
4. Install the alternator.
5. Check the fan belt tension.

Deflection **(A)**	Factory spec.	7.0 to 9.0 mm / 98 N 0.28 to 0.35 in. / 98 N (10 kgf, 22 lbs)

(1) Fan Belt **(A) Deflection**

W1052220

[9] CHECK POINTS OF EVERY 1 OR 2 MONTHS

Recharging

CAUTION

- **When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.**
- **When charging battery, remove battery vent plugs.**
- **When disconnecting the cable from the battery, start with the negative terminal first. When connecting the cable to the battery, start with the positive terminal first.**
- **Never check battery charge by placing a metal object across the posts.**
  Use a voltmeter or hydrometer.

1) Slow Charging

1. Add distilled water if the electrolyte level is low. When charging, the amount of electrolyte should be slightly lower than the specified level to prevent overflow.
2. Connect the battery to the charging unit, following the manufacture's instructions.
3. As the electrolyte generates gas while charging, remove all port caps.
4. The electrolyte temperature must not exceed 40 °C (104 °F) during charging.
   If it exceed 40 °C (104 °F), decrease the charging amperage or stop charging for a while.
5. When charging several batteries in series, charging at the rate of the smallest battery in the line.

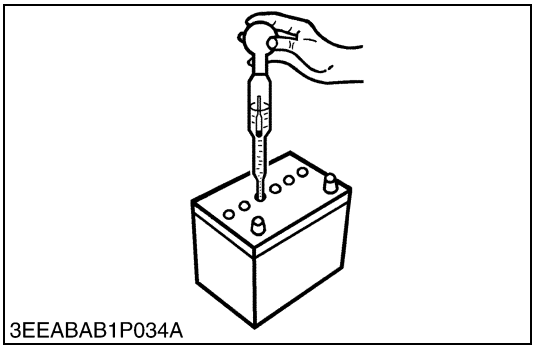
2) Quick Charging

1. Determine the proper charging current and charging time with the tester attached to the quick charger.
2. Determine the proper charging current as 1/1 of the battery capacity. If the battery capacity exceeds 50 Ah, consider 50 A as the maximum.

■ Precaution for Operating a Quick Charger

- Operating with a quick charger differs according to the type. Consult the instruction manual and use accordingly.

W1052658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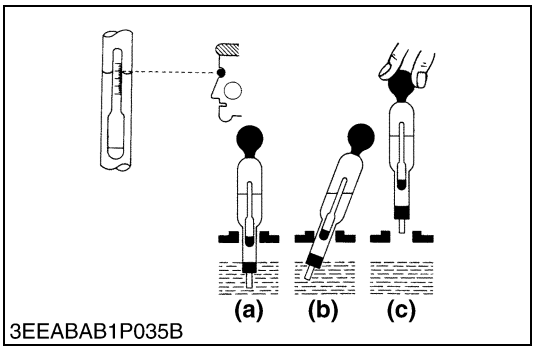

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Battery Specific Gravity

1. Check the specific gravity of the electrolyte in each cell with a hydrometer.
2. When the electrolyte temperature differs from that at which the hydrometer was calibrated, correct the specific gravity reading following the formula mentioned in **(Reference)**.
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity differs between any two cells by more than 0.05, replace the battery.

■ **NOTE**

- **Hold the hydrometer tube vertical without removing it from the electrolyte.**
- **Do not suck too much electrolyte into the tube.**
- **Allow the float to move freely and hold the hydrometer at eye level.**
- **The hydrometer reading must be taken at the highest electrolyte level.**

(Reference)

- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 °C (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 °C (0.0004 with a decrease of 1 °F).
  Therefore, using 20 °C (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :
  - Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature : 20 °C)
  - Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature : 68 °F)

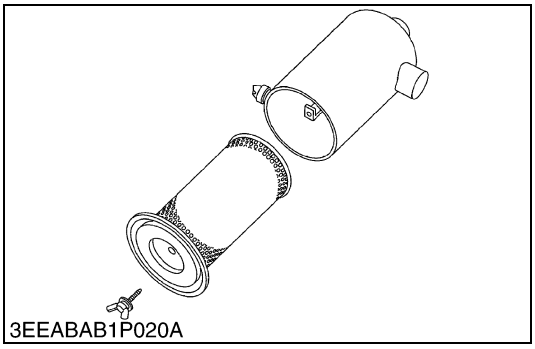
Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

(a) Good
(b) Bad
(c) Bad

W1012763

[10] CHECK POINTS OF EVERY YEAR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Replacing Air Cleaner Element

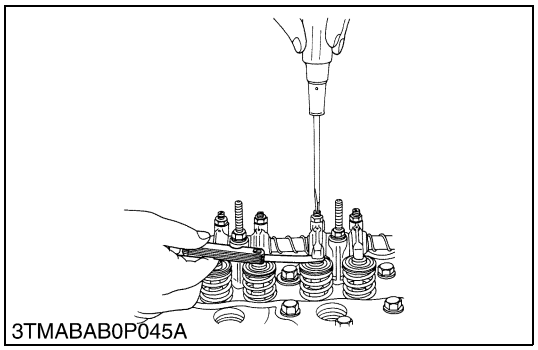
1. Remove used air cleaner element.
2. Replace new air cleaner element.

■ **NOTE**

- **The air cleaner uses a dry element. Never apply oil to it.**
- **Do not run the engine with filter element removed.**

W1020554

[11] CHECK POINTS OF EVERY 800 HOURS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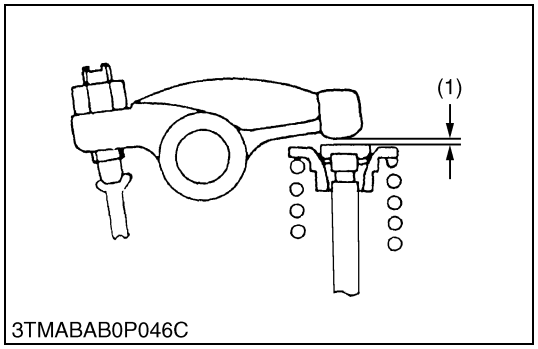

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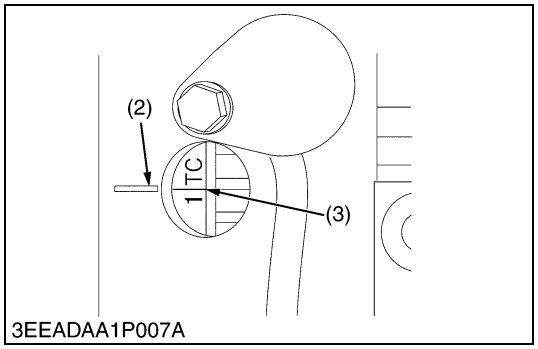

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Valve Clearance

■ **IMPORTANT**

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the head cover.
2. Align the **"1TC"** mark line (3) on the flywheel and projection (2) on the housing so that the No.1 piston comes to the compression or overlap top dead center.
3. Check the following valve clearance (1) marked with "☆" using a feeler gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory spec.	0.18 to 0.22 mm 0.0071 to 0.0087 in.

■ **NOTE**

- **The "TC" marking line on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.**
- **No. 1 piston comes to the top dead center position when the "TC" marking is aligned with the projection (2) in the window on flywheel-housing. Turn the flywheel 0.26 rad (15°) clockwise and counterclockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance (1). (The piston is at the top dead center when both the IN. and EX. valves do not move; it is at the overlap position when both the valves move.)**
- **Finally turn the flywheel 6.28 rad (360°) and align the "TC" marking and the projection (2) perfectly. Adjust all the other valve clearance as required.**
- **After turning the flywheel counterclockwise twice or three times, recheck the valve clearance (1).**
- **After adjusting the valve clearance (1), firmly tighten the lock nut of the adjusting screw.**

Adjustable cylinder location of piston \ Valve arrangement		D1403-E2B D1503-E2B D1703-E2B		V1903-E2B V2203-E2B V2003-TE2B		F2803-E2B	
		IN.	EX.	IN.	EX.	IN.	EX.
When No. 1 piston comes to compression top dead center	No. 1	☆	☆	☆	☆	☆	☆
	No. 2		☆	☆		☆	
	No. 3	☆			☆		☆
	No. 4	–	–				
	No. 5	–	–	–	–		
When No. 1 piston comes to overlap position	No. 1						
	No. 2	☆			☆		☆
	No. 3		☆	☆		☆	
	No. 4	–	–	☆	☆	☆	☆
	No. 5	–	–	–	–	☆	☆

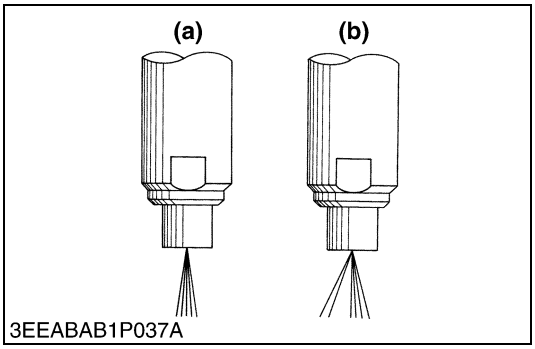
(1) Valve Clearance
(2) Projection
(3) TC Mark Line

W10113200

[12] CHECK POINTS OF EVERY 1500 HOURS

CAUTION

- **Check the injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.**
- **If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.**



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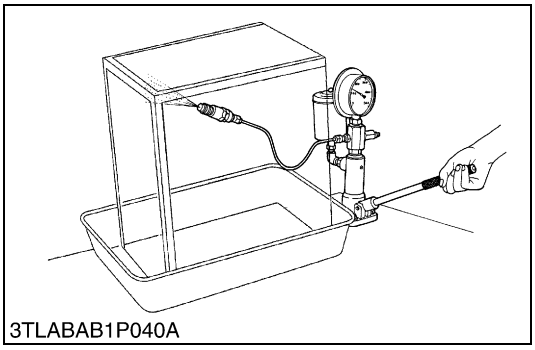
Nozzle Spraying Condition

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the nozzle piece.

(a) Good **(b) Bad**

W10411400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Fuel Injection Pressure

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (1) in the nozzle holder to adjust it.

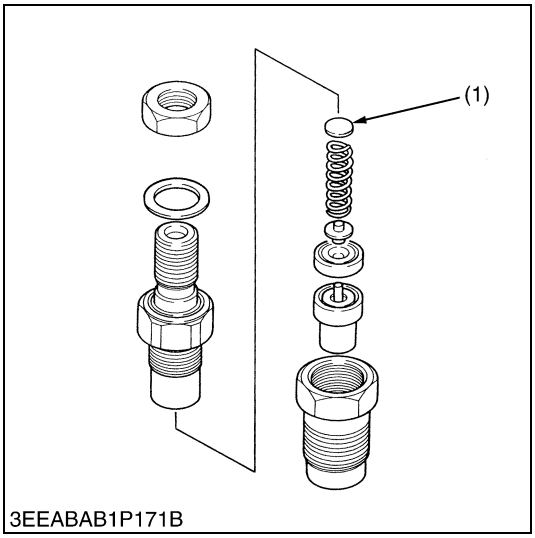
(Reference)

- Pressure variation with 0.025 mm (0.0010 in.) difference of adjusting washer thickness.
  Approx. 588 kPa (6.0 kgf/cm^2, 85 psi)

Fuel injection pressure	Factory spec.	13.73 to 14.71 MPa 140 to 150 kgf/cm^2 1991 to 2134 psi

(1) Adjusting Washer

W10182100



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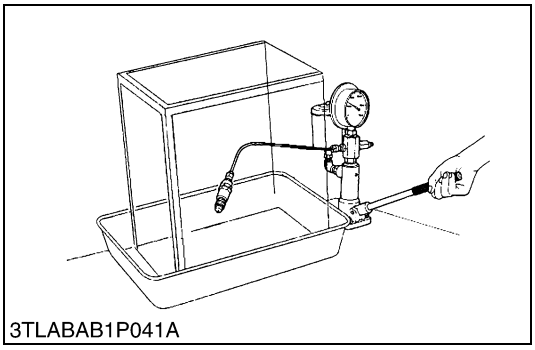
Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130 kgf/cm^2, 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.

Valve seat tightness	Factory spec.	No fuel leak at 12.75 MPa 130 kgf/cm^2 1849 psi

W10412730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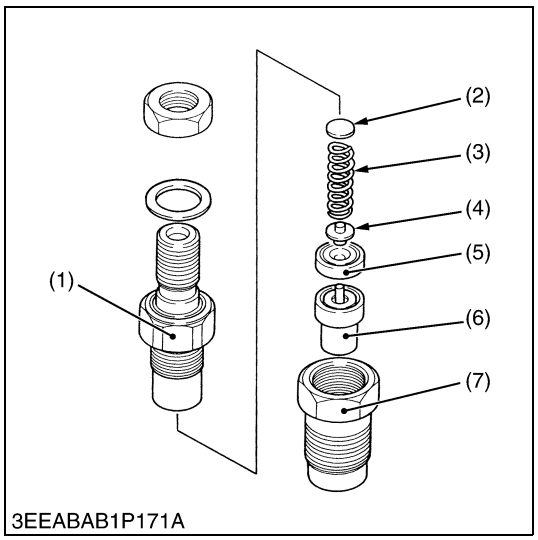


Nozzle Holder

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

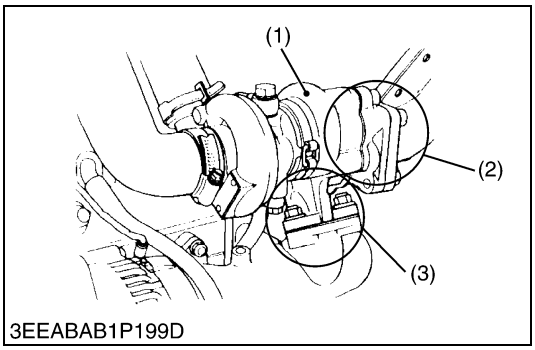
- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.
- After assembling the nozzle, be sure to adjust the fuel injection pressure.

Tightening torque	Nozzle holder	34.3 to 39.2 N·m 3.5 to 4.0 kgf·m 25.3 to 28.9 ft-lbs
	Overflow pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Nozzle holder assembly	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs

(1) Nozzle Holder
(2) Adjusting Washer
(3) Nozzle Spring
(4) Push Rod
(5) Distance Piece
(6) Nozzle Piece
(7) Nozzle Retaining Nut

W1018491

[13] CHECK POINTS OF EVERY 3000 HOURS



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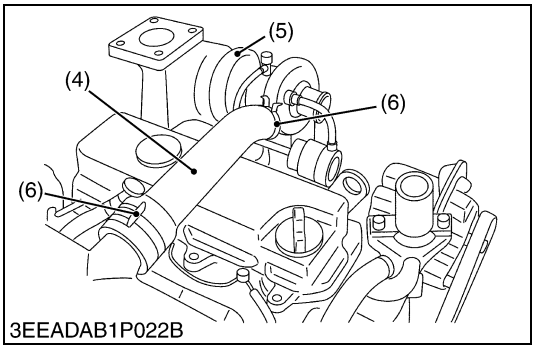

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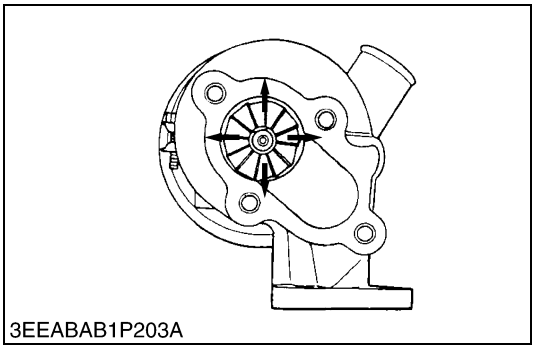
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Checking Turbocharger

(Turbine Side)

1. Check the exhaust port (2) and inlet port (3) side of turbine housing (1) to see if there is no exhaust gas leak.
2. If any gas leak is found, retighten the bolts and nuts or replace the gasket with new one.

(Compressor Side)

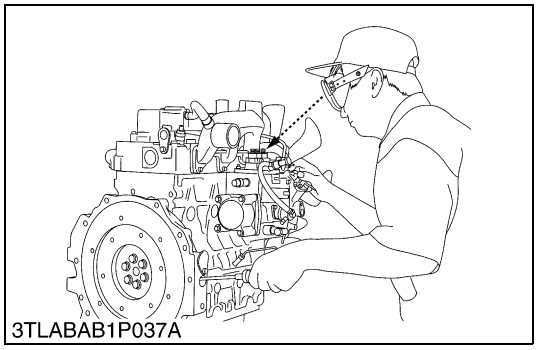
1. Check the inlet hose (4) of the compressor cover (5) to see if there is no air leak.
2. Check for loose connections or cracks in the suction side of the intake hose.
3. If any air leak is found, change the clamp (6) and / or inlet hoses.

(Radial Clearance)

1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

(1) Turbine Housing
(2) Exhaust Port
(3) Inlet Port
(4) Inlet Hose
(5) Compressor Cover
(6) Clamp

W1022082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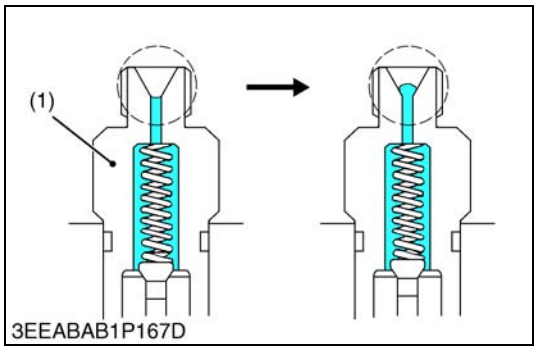

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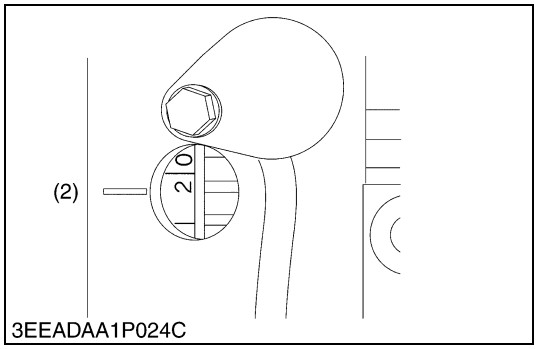

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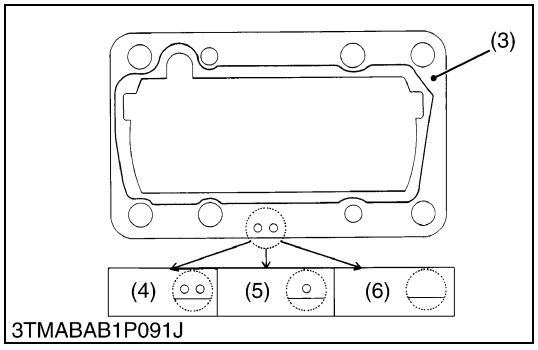

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Injection Timing

1. Remove the injection pipes and nozzle.
2. Set the speed control lever to maximum fuel discharge position.

(Reference)

- Turn the flywheel with screwdriver.

3. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up to the hole of the delivery valve holder for 1st cylinder.
4. Turn the flywheel further and stop turning when the fuel begins to flow over, to get the present injection timing.
5. (The flywheel has mark 1TC and four lines indicating every 0.087 rad (5 °) of crank angle from 0.175 rad (10 °) to 0.436 rad (25 °) before mark 1TC) Calculate the angle which the center of the window points out. If the calculation differs from specified injection timing, add or remove the shim to adjust.

[D1403/D1503/D1703/V1903/V2003-T/V2203-E2B]

Injection timing	Factory spec.	0.297 to 0.331 rad (17 to 19 °) before T.D.C.

[F2803-E2B]

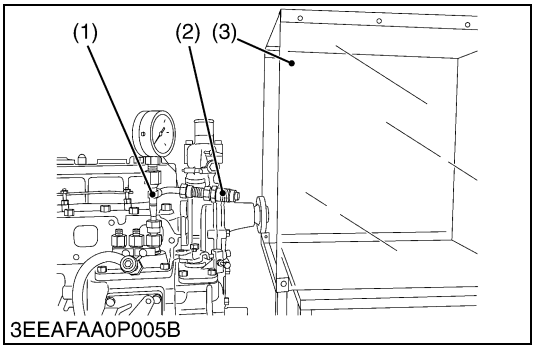
Injection timing	Factory spec.	0.314 to 0.349 rad (18 to 20 °) before T.D.C.

■ **NOTE**

- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Shims are available in thickness of 0.20 mm, 0.25 mm and 0.30 mm. Combine these shims for adjustments.**
- **Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5 °).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

(1) Delivery Valve Holder
(2) Timing Mark
(3) Shim (Soft Metal Gasket Shim)
(4) 2-holes : 0.20 mm (Shim)
(5) 1-hole : 0.25 mm (Shim)
(6) Without hole : 0.30 mm (Shim)

W1023147



Checking Injection Pump

(Fuel Tightness of Pump Element)

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

(Fuel Tightness of Delivery Valve)

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by hand and raise the pressure to approx. 13.73 MPa (140 kgf/cm^2, 1991 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 13.73 to 12.75 MPa (from 140 to 130 kgf/cm^2, from 1991 to 1849 psi).
8. Measure the time needed to decrease the pressure from 13.73 to 12.75 MPa (from 140 to 130 kgf/cm^2, from 1991 to 1849 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of pump element	Allowable limit	13.73 MPa 140 kgf/cm^2 1991 psi
Fuel tightness of delivery valve	Factory spec.	10 seconds 13.73 → 12.75 MPa 140 → 130 kgf/cm^2 1991 → 1849 psi
	Allowable limit	5 seconds 13.73 → 12.75 MPa 140 → 130 kgf/cm^2 1991 → 1849 psi

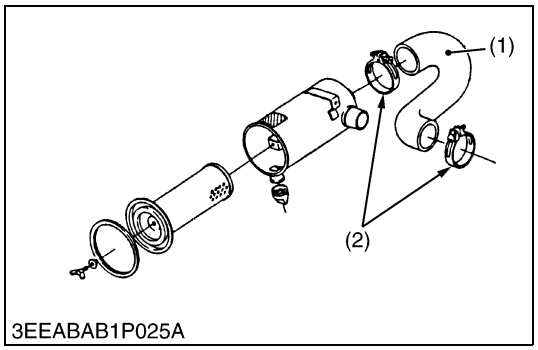
■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1022357

[14] CHECK POINTS OF EVERY 2 YEARS



3EEABAB1P025A

Replacing Intake Air Line

1. Loosen the clamp (2).
2. Remove the intake air hose (1) and clamp (2).
3. Replace new intake air hose (1) and new clamp (2).
4. Tighten the clamp (2).

■ **NOTE**

- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

(1) Intake Air Hose (2) Clamp

W1023867

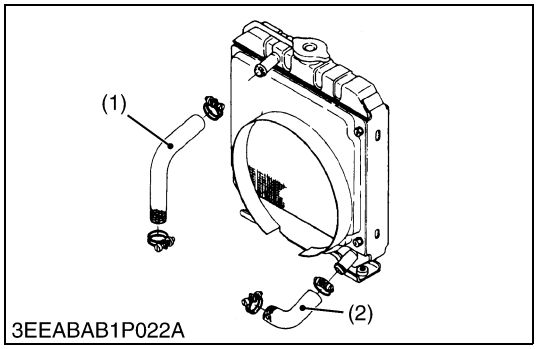
Replacing Battery

CAUTION

- **When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.**
- **When charging battery, remove battery vent plugs.**
- **When disconnecting the cable from the battery, start with the negative terminal first. When connecting the cable to the battery, start with the positive terminal first.**
- **Never check battery charge by placing a metal object across the posts.**

1. Disconnect the negative terminal and positive terminal.
2. Remove the battery holder.
3. Remove the used battery.
4. Replace the new battery.
5. Tighten the battery holder.
6. Connect the positive terminal.
7. Connect the negative terminal.

W1023996



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Replacing Radiator Hoses and Clamp Bands

CAUTION

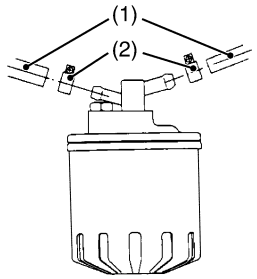
- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Drain the coolant.
2. Loosen the clamp bands.
3. Remove the upper hose (1) and lower hose (2).
4. Replace new upper / lower hose (1), (2) and clamp bands.
5. Tighten the clamp bands.
6. Fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap securely.

(1) Upper Hose (2) Lower Hose

W1024178

[A]



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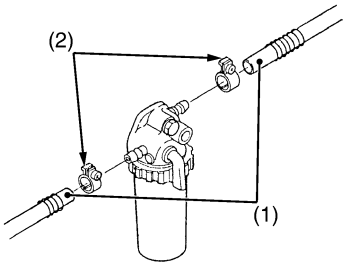

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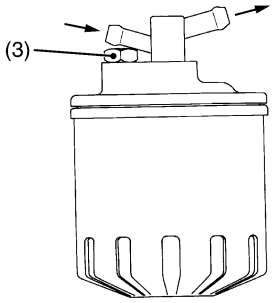

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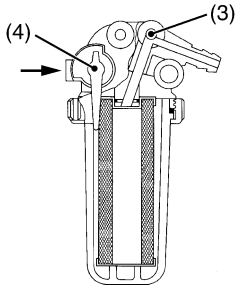

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Replacing Fuel Hoses and Clamp Bands

1. Loosen the clamp (2) and remove the fuel hose (1).
2. Replace new fuel hose (1) and new clamp (2).
3. Tighten the clamp (2).

CAUTION

- **Stop the engine when attempting the check and change prescribed above.**

(When bleeding fuel system)

1. Fill the tank with fuel and open the cock (4).
2. Loosen the air vent plug (3) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent cock on top of the fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key to **AC** position and pump the fuel up for 10 to 15 seconds.
   If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent cock after air bleeding.

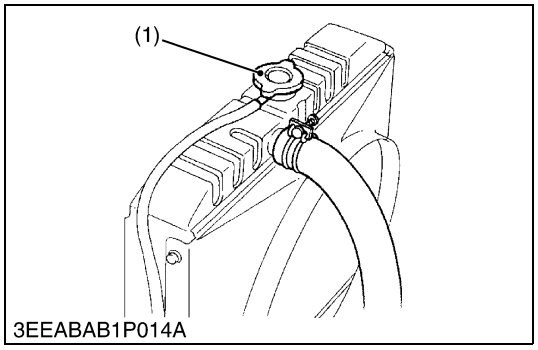
NOTE

- **Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.**

(1) Fuel Hose
(2) Clamp
(3) Air Vent Plug
(4) Fuel Cock

[A] Cartridge Type
[B] Element Type

W1024305



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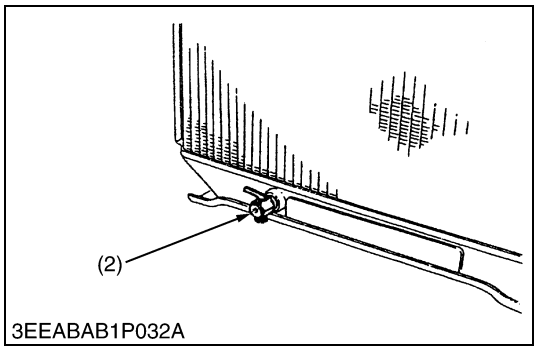

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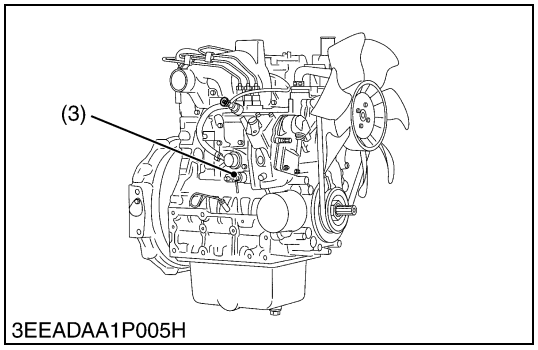

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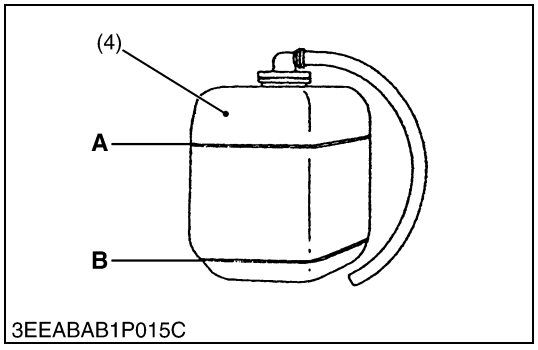

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Changing Radiator Coolant (L.L.C.)

CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Stop the engine and let cool down.
2. To drain the coolant, open the radiator drain plug (2) and remove the radiator cap (1). Then radiator cap (1) must be removed to completely drain the coolant. And open the drain cock (3).
3. After all coolant is drained, close the drain plug.
4. Fill with clean water and cooling system cleaner.
5. Follow directions of the cleaner instruction.
6. After flushing, fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap (1) securely.
7. Fill with coolant up to “FULL” (**A**) mark on the recovery tank (4).
8. Start and operate the engine for few minutes.
9. Stop the engine and let cool. Check coolant level of radiator and recovery tank (4) and add coolant if necessary.

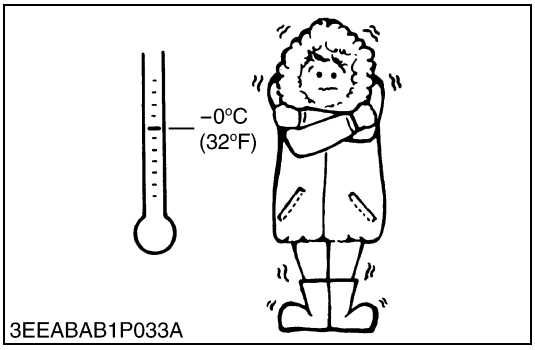
■ **IMPORTANT**

- **Do not start engine without coolant.**
- **Use clean, fresh, soft water and anti-freeze to fill the radiator and recovery tank.**
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**
- **Securely tighten radiator cap. If the cap is loose or improperly fitted, water may leak out and the engine could overheat.**

(1) Radiator Cap
(2) Drain Plug
(3) Drain Cock
(4) Recovery Tank

A : Full
B : Low

W1024599



Changing Radiator Coolant (L.L.C.) (Continued)

(Anti-freeze)

- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Before adding anti-freeze for the first time, clean the radiator interior by pouring fresh, soft water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Basically, it should be referred to SAE J1034 standard, more specifically also to SAE J814c.
- Mix the anti-freeze with fresh, soft water, and then fill into the radiator.

■ **IMPORTANT**

- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**

Vol % anti-freeze	Freezing point		Boiling point*	
	°C	°F	°C	°F
40	–24	–11.2	106	222.8
50	–37	–34.6	108	226.4

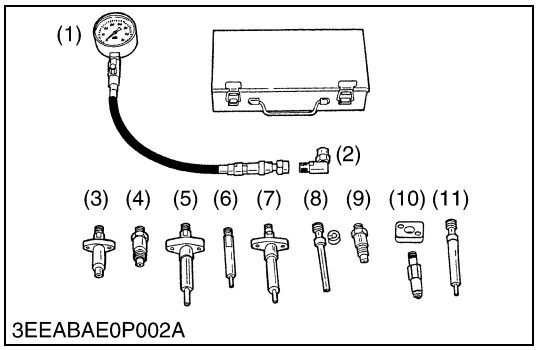
* At 1.013 × 100000 Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

■ **NOTE**

- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.**
- **When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and fresh, soft water in the specified mixing ratio.**
- **Anti-freeze absorbs moisture. Keep unused anti-freeze in a tightly sealed container.**
- **Do not use radiator cleaning agents when anti-freeze has been added to the coolant.**
  (Anti-freeze contains an anti-corrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine parts.)

W1024852

5. SPECIAL TOOLS



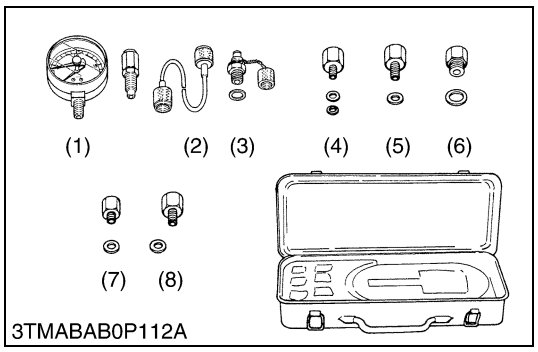
Diesel Engine Compression Tester

Code No: 07909-30208 (Assembly) 07909-31251 (G)
07909-30934 (A to F) 07909-31271 (I)
07909-31211 (E and F) 07909-31281 (J)
07909-31231 (H)

Application: Use to measure diesel engine compression and diagnosis of need for major overhaul.

(1) Gauge
(2) **L** Joint
(3) Adaptor **A**
(4) Adaptor **B**
(5) Adaptor **C**
(6) Adaptor **E**
(7) Adaptor **F**
(8) Adaptor **G**
(9) Adaptor **H**
(10) Adaptor **I**
(11) Adaptor **J**

W1024200



Oil Pressure Tester

Code No: 07916-32032

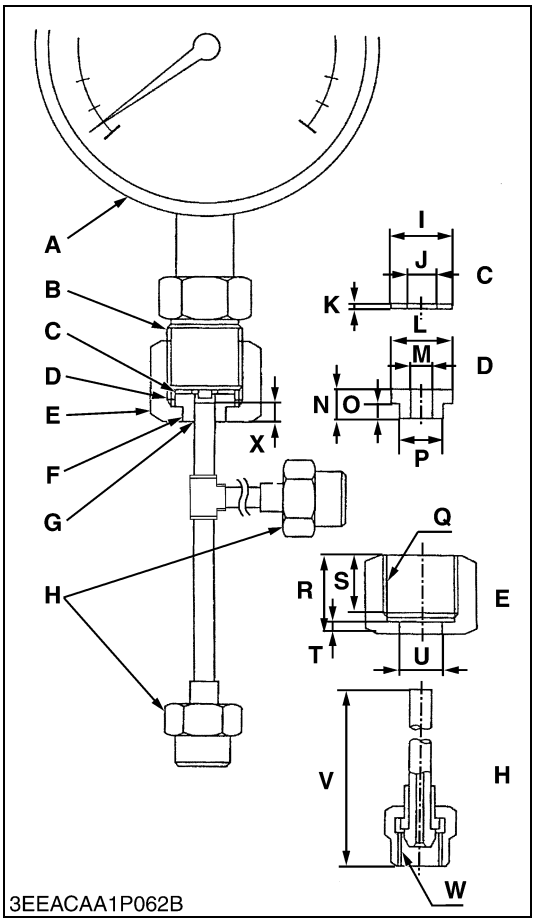
Application: Use to measure lubricating oil pressure.

(1) Gauge
(2) Cable
(3) Threaded Joint
(4) Adaptor **1**
(5) Adaptor **2**
(6) Adaptor **3**
(7) Adaptor **4**
(8) Adaptor **5**

W1024318

■ **NOTE**

- **The following special tools are not provided, so make them referring to the figure.**



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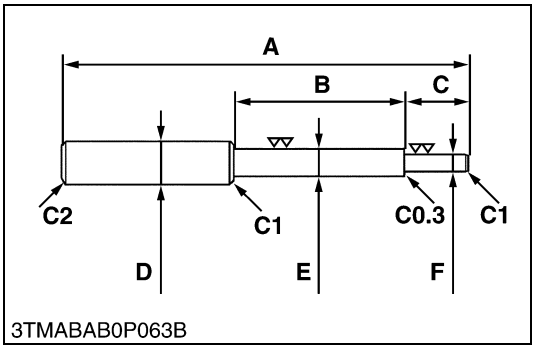
Injection Pump Pressure Tester

Application: Use to check fuel tightness of injection pumps.

A	Pressure gauge full scale : More than 29.4 MPa (300 kgf/cm^2, 4267 psi)
B	PF 1/2
C	Copper gasket
D	Flange (Material : Steel)
E	Hex. nut 27 mm (1.06 in.) across the plat
F	Adhesive application
G	Fillet welding on the enter circumference
H	Retaining nut
I	17 mm dia. (0.67 in. dia.)
J	8 mm dia. (0.31 in. dia.)
K	1.0 mm (0.039 in.)
L	17 mm dia. (0.67 in. dia.)
M	6.10 to 6.20 mm dia. (0.2402 to 0.2441 in. dia.)
N	8 mm (0.31 in.)
O	4 mm (0.16 in.)
P	11.97 to 11.99 mm dia. (0.4713 to 0.4720 in. dia.)
Q	PF 1/2
R	23 mm (0.91 in.)
S	17 mm (0.67 in.)
T	4 mm (0.16 in.)
U	12.00 to 12.02 mm dia. (0.4724 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5 mm (0.20 in.)

W10252400



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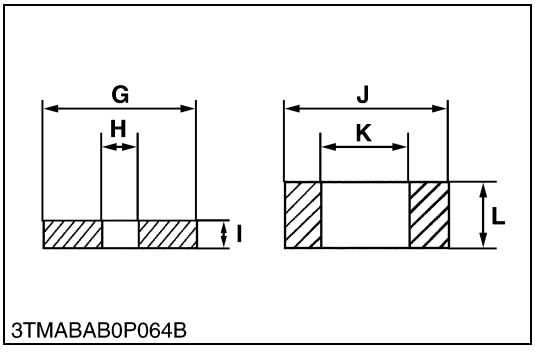
Valve Guide Replacing Tool

Application: Use to press out and press in the valve guide.

A	225 mm (8.86 in.)
B	70 mm (2.76 in.)
C	45 mm (1.77 in.)
D	20 mm dia. (0.79 in. dia.)
E	12.7 to 12.9 mm dia. (0.500 to 0.508 in. dia.)
F	7.5 to 7.6 mm dia. (0.295 to 0.299 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	7.7 to 8.0 mm dia. (0.303 to 0.315 in. dia.)
I	5 mm (0.197 in.)
J	20 mm dia. (0.787 in. dia.)
K	13.5 to 13.8 mm dia. (0.531 to 0.543 in. dia.)
L	8.9 to 9.1 mm (0.350 to 0.358 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.3 mm (0.012 in.)

W1025017



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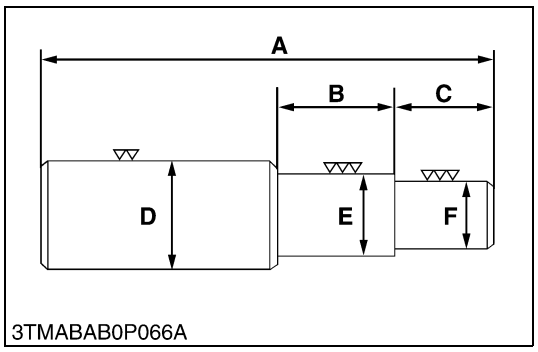


3TMABAB0P066A

Bushing Replacing Tools

Application: Use to press out and to press in the bushing.

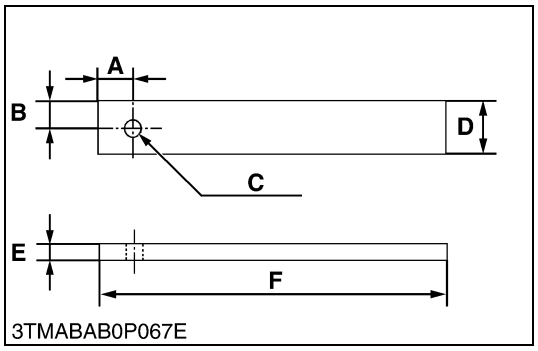
1. For small end bushing

A	162 mm (6.38 in.)
B	35 mm (1.38 in.)
C	27 mm (1.06 in.)
D	35 mm dia. (1.38 in. dia.)
E	27.90 to 27.95 mm dia. (1.098 to 1.100 in. dia.)
F	25.00 to 25.01 mm dia. (0.984 to 0.985 in. dia.)

2. For idle gear bushing

A	175 mm (6.89 in.)
B	40 mm (1.57 in.)
C	38 mm (1.50 in.)
D	45 mm dia. (1.77 in. dia.)
E	41.90 to 41.95 mm dia. (1.650 to 1.652 in. dia.)
F	37.95 to 37.97 mm dia. (1.494 to 1.495 in. dia.)

W1025500



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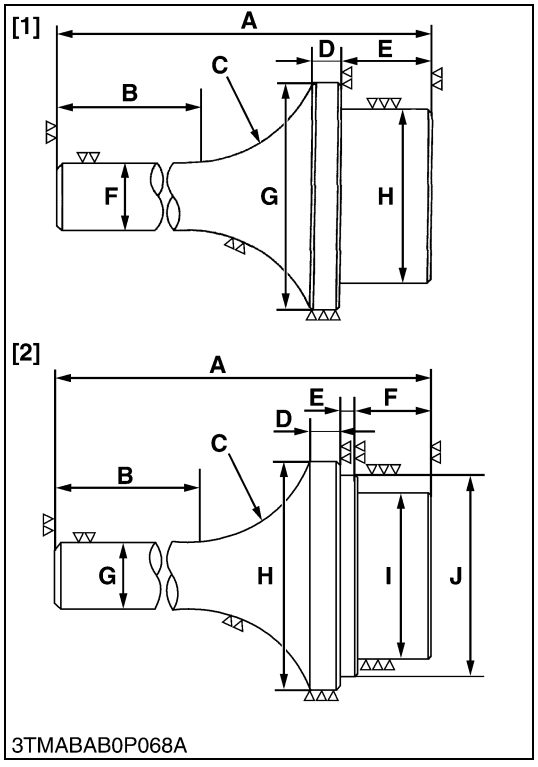
Flywheel Stopper

Application: Use to loosen and tighten the flywheel screw.

A	20 mm (0.79 in.)
B	15 mm (0.59 in.)
C	10 mm dia. (0.39 in. dia.)
D	30 mm (1.18 in.)
E	8 mm (0.31 in.)
F	200 mm (7.87 in.)

W10259480



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Crankshaft Bearing 1 Replacing Tool (F2803-E2B)

Application: Use to press out and press in the crankshaft bearing 1.

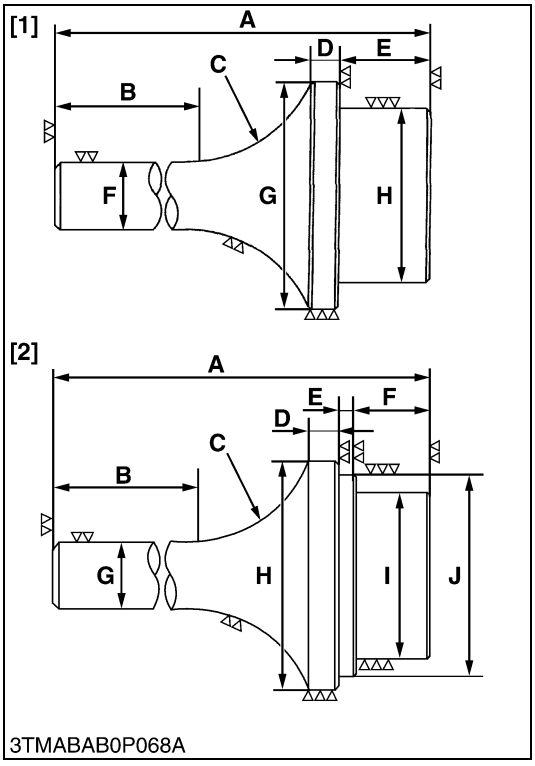
1. Extracting tool

A	135 mm (5.31 in.)
B	72 mm (2.83 in.)
C	40 mm radius (1.57 in. radius)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	56.8 to 56.9 mm dia. (2.236 to 2.240 in. dia.)
H	51.8 to 51.9 mm dia. (2.039 to 2.043 in. dia.)

2. Inserting tool

A	130 mm (5.12 in.)
B	72 mm (2.83 in.)
C	40 mm radius (1.57 in. radius)
D	9 mm (0.35 in.)
E	4 mm (0.16 in.)
F	20 mm (0.79 in.)
G	20 mm dia. (0.79 in. dia.)
H	68 mm dia. (2.68 in. dia.)
I	51.8 to 51.9 mm dia. (2.039 to 2.043 in. dia.)
J	56.8 to 56.9 mm dia. (2.236 to 2.240 in. dia.)

W1026139



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Crankshaft Bearing 1 Replacing Tool (D1403/D1503/D1703/V1903/V2003-T/V2203-E2B)

Application: Use to press out and press in the crankshaft bearing 1.

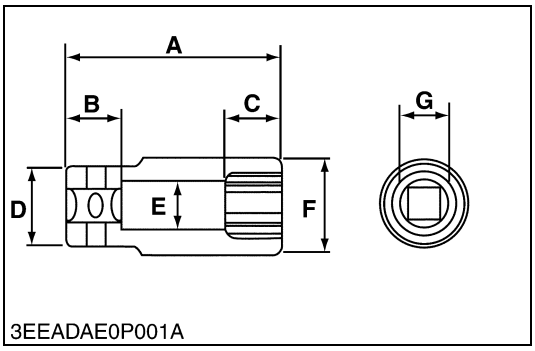
1. Extracting tool

A	135 mm (5.31 in.)
B	72 mm (2.83 in.)
C	40 mm radius (1.57 in. radius)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	64.8 to 64.9 mm dia. (2.551 to 2.555 in. dia.)
H	59.8 to 59.9 mm dia. (2.354 to 2.358 in. dia.)

2. Inserting tool

A	130 mm (5.12 in.)
B	72 mm (2.83 in.)
C	40 mm radius (1.57 in. radius)
D	9 mm (0.35 in.)
E	4 mm (0.16 in.)
F	20 mm (0.79 in.)
G	20 mm dia. (0.79 in. dia.)
H	68 mm dia. (2.68 in. dia.)
I	59.8 to 59.9 mm dia. (2.354 to 2.358 in. dia.)
J	64.8 to 64.9 mm dia. (2.551 to 2.555 in. dia.)

W1025644



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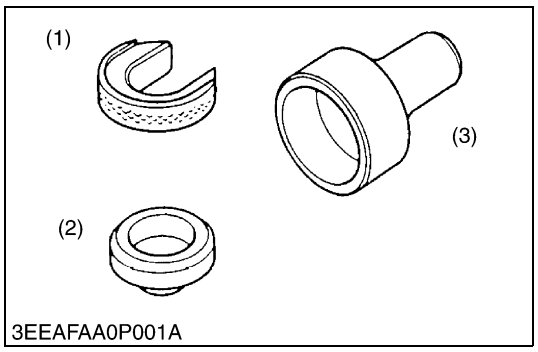
Socket Wrench for Crank Pulley Nut (46 mm Deep Socket Wrench)

Application: Use to loosen and tighten the fan drive pulley mounting nut.

A	100 mm (3.94 in.)
B	25.0 mm (0.98 in.)
C	27.0 mm (1.06 in.)
D	45.0 mm dia. (1.77 in. dia.)
E	35.0 mm dia. (1.38 in. dia.)
F	62.5 mm dia. (2.46 in. dia.)
G	46.0 mm (1.81 in.)

W1044361



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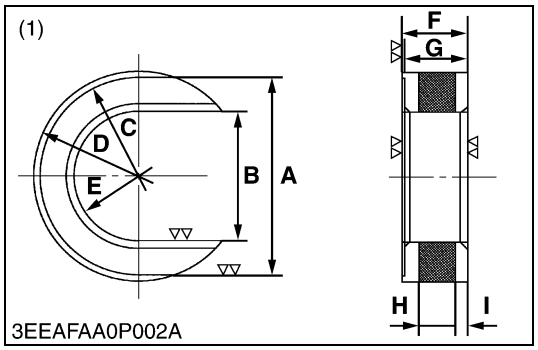

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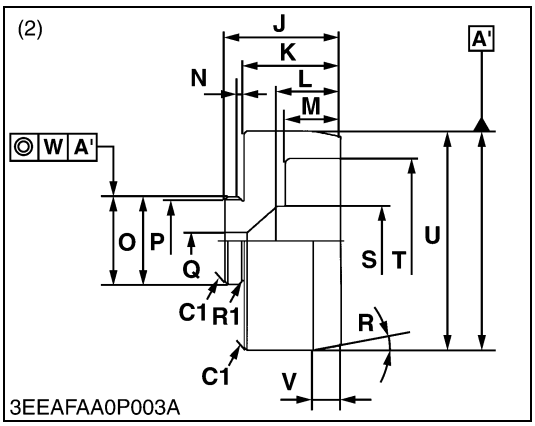
Auxiliary Socket for Fixing Crankshaft Sleeve

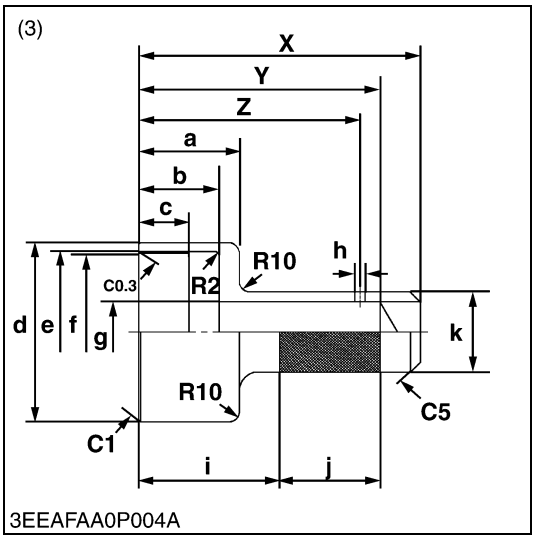
Application: Use to fix the crankshaft sleeve of the diesel engine.

A	80.0 mm (3.1496 in.)	
B	F2803-E2B	52.1 to 52.3 mm (2.0512 to 2.0591 in.)
	D1403-E2B D1503-E2B D1703-E2B V1903-E2B V2003-TE2B V2203-E2B	60.1 to 60.3 mm (2.3661 to 2.3740 in.)
C	80.0 mm dia. (3.1496 in. dia.)	
D	85.0 mm dia. (3.3465 in. dia.)	
E	F2803-E2B	52.1 to 52.3 mm dia. (2.0512 to 2.0591 in. dia.)
	D1403-E2B D1503-E2B D1703-E2B V1903-E2B V2003-TE2B V2203-E2B	60.1 to 60.3 mm dia. (2.3661 to 2.3740 in. dia.)
F	26.3 to 26.4 mm (1.0354 to 1.0394 in.)	
G	25.85 to 25.90 mm (1.0177 to 1.0197 in.)	
H	15.0 mm (0.5906 in.)	
I	5.0 mm (0.1969 in.)	

(1) Stopper
(2) Sleeve Guide
(3) Auxiliary Socket for Pushing

W1027695





Auxiliary Socket for Fixing Crankshaft Sleeve (Continued)

Application: Use to fix the crankshaft sleeve of the diesel engine.

J	42.0 mm (1.6535 in.)
K	30.5 to 30.6 mm (1.2008 to 1.2047 in.)
L	23.0 mm (0.9055 in.)
M	20.0 mm (0.7874 in.)
N	2.0 mm (0.0787 in.)
O	31.911 to 31.950 mm dia. (1.2563 to 1.2579 in. dia.)
P	30.0 mm dia. (1.1811 in. dia.)
Q	5.0 mm dia. (0.1969 in. dia.)
R	0.087 rad (5 °)
S	25.0 mm dia. (0.9843 in. dia.)
T	60.0 mm dia. (2.3622 in. dia.)
U	79.80 to 79.85 mm dia. (3.1417 to 3.1437 in. dia.)
V	10.0 mm (0.3937 in.)
W	0.04 mm dia. (0.0016 in. dia.)
X	140 mm (5.5118 in.)
Y	120 mm (4.7244 in.)
Z	110 mm (4.3307 in.)
a	50.0 mm (1.9685 in.)
b	39.9 to 40.0 mm (1.5709 to 1.5748 in.)
c	25.0 mm (0.9843 in.)
d	90.0 mm dia. (3.5433 in. dia.)
e	81.0 mm dia. (3.1890 in. dia.)
f	80.10 to 80.15 mm dia. (3.1535 to 3.1555 in. dia.)
g	30.0 mm dia. (1.1811 in. dia.)
h	5.0 mm dia. (0.1969 in. dia.)
i	70.0 mm (2.7559 in.)
j	50.0 mm (1.9685 in.)
k	40.0 mm dia. (1.5748 in. dia.)
C1	Chamfer 1.0 mm (0.0394 in.)
C5	Chamfer 5.0 mm (0.1969 in.)
C0.3	Chamfer 0.3 mm (0.012 in.)
R1	1.0 mm radius (0.0394 in. radius)
R2	2.0 mm radius (0.0787 in. radius)
R10	10.0 mm radius (0.3937 in. radius)

(2) Sleeve Guide (3) Auxiliary Socket for Pushing

W1027898

MECHANISM

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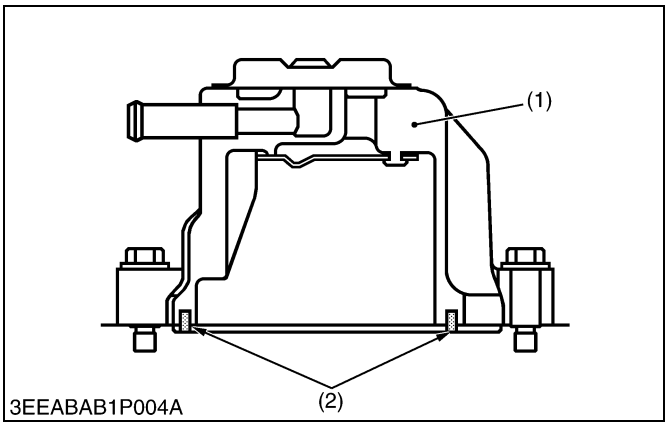
2. FUEL SYSTEM M-2
   [1] GOVERNOR M-2

1. ENGINE BODY

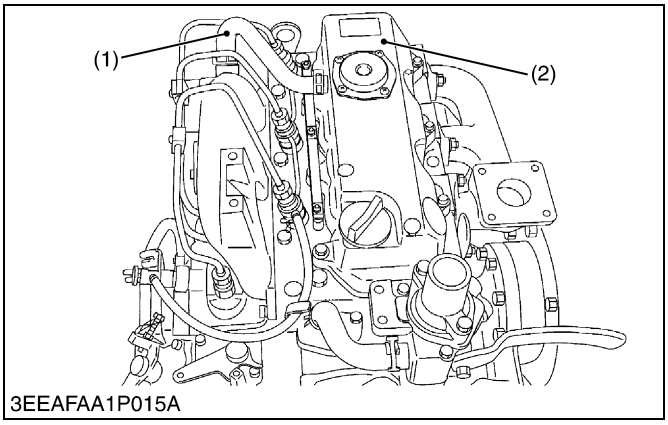
[1] HALF-FLOATING HEAD COVER

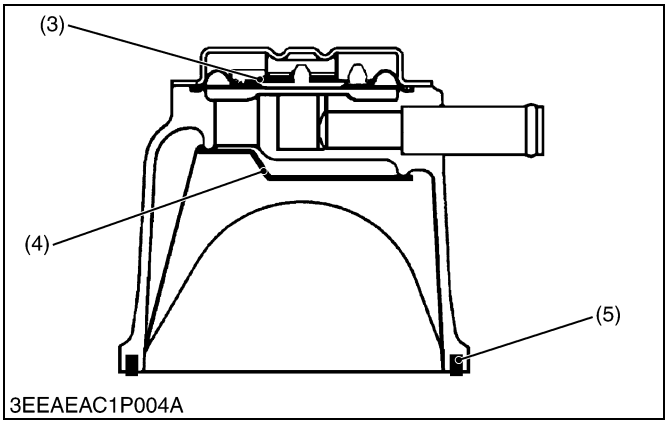


The rubber packing is fitted in to maintain the cylinder head cover 0.5 mm (0.02 in.) or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

(1) Cylinder Head Cover (2) Rubber Packing

[2] CLOSED BREATHER (D1403 / D1503 / D1703 / V1903 / V2203-E2B)





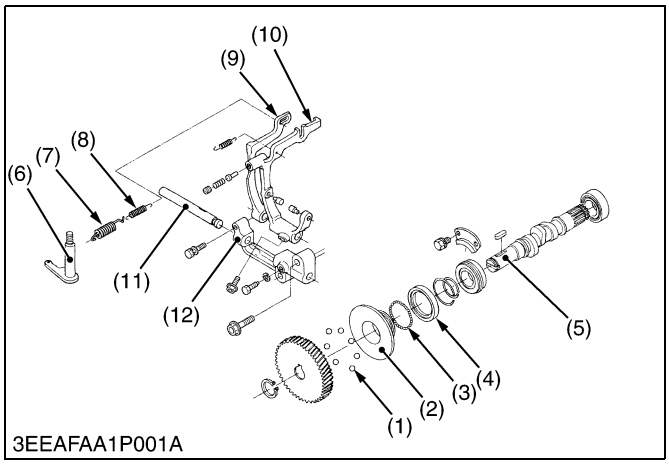
Closed breather system has been adopted to prevent the release of blow-by gas into the atmosphere.

After its oil content is filtered by oil shield (4), the blow-by gas is fed back to the intake manifold through breather valve (3) to be used for re-combustion.

(1) Breather Hose
(2) Cylinder Head Cover
(3) Breather Valve
(4) Oil Shield
(5) Rubber Packing

2. FUEL SYSTEM

[1] GOVERNOR



The governor serves to keep engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. This engine employs an all-speed governor which controls the centrifugal force of the steel ball (1) weight, produced by rotation of the fuel camshaft (5), and the tension of the governor spring 1 (7) and 2 (8) are balanced.

(1) Steel Ball
(2) Governor Sleeve
(3) Steel Ball
(4) Governor Ball Case
(5) Fuel Camshaft
(6) Governor Lever
(7) Governor Spring 1
(8) Governor Spring 2
(9) Fork Lever 2
(10) Fork Lever 1
(11) Fork Lever Shaft
(12) Fork Lever Holder

SERVICING

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1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	G-10
	Air in the fuel system	Vent air	G-10
	Water in the fuel system	Change fuel and repair or replace fuel system	–
	Fuel hose clogged	Clean or replace	G-10
	Fuel filter clogged	Replace	G-10, 17
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	4, 5, 6, G-8
	Fuel with low cetane number	Use specified fuel	4, 5, 6
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-31
	Incorrect injection timing	Adjust	S-20
	Fuel camshaft worn	Replace	S-39
	Injection nozzle clogged	Repair or replace	S-22, 23
	Injection pump malfunctioning	Repair or replace	S-21, 35
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	S-38 to 43 S-60 to 67
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	S-31, 32, 33
	Improper valve timing	Correct or replace timing gear	S-38
	Piston ring and cylinder worn	Replace	S-41, 42, 43, 59
	Excessive valve clearance	Adjust	S-16
	Stop solenoid malfunctioning	Replace	–
Starter Does Not Run	Battery discharged	Charge	G-20
	Starter malfunctioning	Repair or replace	S-28, 68, 69, 70
	Key switch malfunctioning	Replace	–
	Wiring disconnected	Connect	–

W1014322

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Symptom	Probable Cause	Solution	Reference Page
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Replace	G-10, 17
	Air cleaner clogged	Clean or replace	G-11, 16, 21
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-31
	Injection pump malfunctioning	Repair or replace	S-21, 35
	Incorrect nozzle opening pressure	Repair or replace	S-22
	Injection nozzle stuck or clogged	Repair or replace	S-22, 23
	Governor malfunctioning	Repair	S-35, 36, 39
	Turbocharger bearing worn out	Replace the turbocharger assembly	S-27
	Turbocharger shaft bent	Replace the turbocharger assembly	S-27
	Turbocharger fin or other part damaged due to foreign matters	Replace the turbocharger assembly	S-27
Either White or Blue Exhaust Gas Is Observed	Excessive engine oil	Reduce to specified level	G-6
	Piston ring and cylinder worn or stuck	Repair or replace	S-41, 42, 43, 59
	Incorrect injection timing	Adjust	S-20
Oil Leak into Exhaust Pipe or Suction Pipe	Oil pipe clogged or deformed	Repair or replace	S-27
	Turbocharger's piston ring seal faulty	Replace the turbocharger assembly	S-27
Either Black or Dark Gray Exhaust Gas Is Observed	Overload	Reduce the load	–
	Low grade fuel used	Use specified fuel	4, 5, 6
	Fuel filter clogged	Replace	G-10, 17
	Air cleaner clogged	Clean or replace	G-11, 16, 21
	Deficient nozzle injection	Repair or replace nozzle	S-22, 23

W1011567

Symptom	Probable Cause	Solution	Reference Page
Deficient Output	Incorrect injection timing	Adjust	S-20
	Engine's moving parts seem to be seizing	Repair or replace	–
	Injection pump malfunctioning	Repair or replace	S-21, 35
	Deficient nozzle injection	Repair or replace nozzle	S-22, 23
	Compression leak	Check the compression pressure and repair	S-15
	Gas leak from exhaust system	Repair or replace	S-27, 29
	Air leak from compressor discharge side	Repair or replace	S-27, 29
	Air cleaner dirty or clogged	Clean or replace	G-11, 16, 21
	Turbocharger compressor wheel turning heavily	Replace the turbocharger assembly	S-27
Excessive Lubricant OIl Consumption	Piston ring's gap facing the same direction	Shift ring gap direction	S-42
	Oil ring worn or stuck	Replace	S-41, 42, 43
	Piston ring groove worn	Replace piston	S-41, 42, 43
	Valve stem and valve guide worn	Replace	S-34, 50, 51
	Crankshaft bearing and crank pin bearing worn	Replace	S-46, 61 to 64
	Oil leaking due to defective seals or packing	Replace	–
Fuel Mixed into Lubricant Oil	Injection pump's plunger worn	Repair or replace	S-21, 35
	Deficient nozzle injection	Repair or replace nozzle	S-22, 23
	Injection pump broken	Replace	S-35
Water Mixed into Lubricant Oil	Head gasket defective	Replace	S-33
	Cylinder block or cylinder head flawed	Replace	S-33
Low Oil Pressure	Engine oil insufficient	Replenish	G-6
	Oil strainer clogged	Clean	S-40
	Relief valve stuck with dirt	Clean	–
	Relief valve spring weaken or broken	Replace	–
	Excessive oil clearance of crankshaft bearing	Replace	S-45
	Excessive oil clearance of crankpin bearing	Replace	S-41, 42, 43
	Excessive oil clearance of rocker arm	Replace	S-32
	Oil passage clogged	Clean	–
	Different type of oil	Use specified type of oil	G-8
	Oil pump defective	Replace	S-39

W1012032

Symptom	Probable Cause	Solution	Reference Page
High Oil Pressure	Different type of oil	Use specified type of oil	G-8
	Relief valve defective	Replace	–
Engine overheated	Engine oil insufficient	Replenish	G-6
	Fan belt broken or elongated	Replace or adjust	G-11, 12
	Coolant insufficient	Replenish	G-7
	Radiator net and radiator fin clogged with dust	Clean	–
	Inside of radiator corroded	Clean or replace	G-18
	Coolant flow route corroded	Clean or replace	G-18, 19
	Radiator cap defective	Replace	S-18
	Overload running	Reduce the load	–
	Head gasket defective	Replace	S-33
	Incorrect injection timing	Adjust	S-20
	Unsuitable fuel used	Use specified fuel	4, 5, 6
Battery Quickly Discharged	Battery electrolyte insufficient	Replenish distilled water and charge	G-11
	Fan belt slips	Adjust belt tension or replace	G-11, 12
	Wiring disconnected	Connect	–
	Rectifier defective	Replace	S-71
	Alternator defective	Replace	S-26
	Battery defective	Replace	G-28

W1012501

2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Valve Clearance (When Cold)		0.18 to 0.22 mm 0.0071 to 0.0087 in.	–
Compression Pressure (When Cranking with Starting Motor)		3.53 to 3.72 MPa / 290 min^{-1} (rpm) 36 to 38 kgf/cm^2 / 290 min^{-1} (rpm) 512 to 540 psi / 290 min^{-1} (rpm)	2.55 MPa / 290 min^{-1} (rpm) 26 kgf/cm^2 / 290 min^{-1} (rpm) 370 psi / 290 min^{-1} (rpm)
Difference among Cylinders		–	10 % or less
Top Clearance		0.55 to 0.70 mm 0.0217 to 0.0276 in.	–
Cylinder Head Surface	Flatness	–	0.05 mm 0.0020 in.
Valve Recessing	Protrusion	0.05 mm 0.0020 in.	–
	Recessing	0.15 mm 0.0059 in.	0.40 mm 0.0157 in.
Valve Stem to Valve Guide	Clearance	0.040 to 0.070 mm 0.00157 to 0.00276 in.	0.10 mm 0.0039 in.
Valve Stem	O.D.	7.960 to 7.975 mm 0.31339 to 0.31398 in.	–
Valve Guide	I.D.	8.015 to 8.030 mm 0.31555 to 0.31614 in.	–
Valve Face	Angle (Intake)	1.047 rad 60 °	–
	Angle (Exhaust)	0.785 rad 45 °	–
Valve Seat	Angle (Intake)	1.047 rad 60 °	–
	Angle (Exhaust)	0.785 rad 45 °	–
Valve Seat	Width (Intake)	2.12 mm 0.0835 in.	–
	Width (Exhaust)	2.12 mm 0.0835 in.	–

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Valve Timing (Intake Valve) **[D1403-E2B]** **[D1503-E2B]**	Open	0.14 rad (8 °) before T.D.C.	–
	Close	0.35 rad (20 °) after B.D.C.	–
Valve Timing (Intake Valve) **[D1703-E2B]** **[V1903-E2B]** **[V2203-E2B]** **[F2803-E2B]**	Open	0.21 rad (12 °) before T.D.C.	–
	Close	0.63 rad (36 °) after B.D.C.	–
Valve Timing (Intake Valve) **[V2003-TE2B]**	Open	0.35 rad (20 °) before T.D.C.	–
	Close	0.79 rad (45 °) after B.D.C.	–
Valve Timing (Exhaust Valve) **[D1403-E2B]** **[D1503-E2B]**	Open	1.05 rad (60 °) before B.D.C.	–
	Close	0.21 rad (12 °) after T.D.C.	–
Valve Timing (Exhaust Valve) **[D1703-E2B]** **[V1903-E2B]** **[V2203-E2B]** **[F2803-E2B]**	Open	1.05 rad (60 °) before B.D.C.	–
	Close	0.21 rad (12 °) after T.D.C.	–
Valve Timing (Exhaust Valve) **[V2003-TE2B]**	Open	0.96 rad (55 °) before B.D.C.	–
	Close	0.24 rad (14 °) after T.D.C.	–
Valve Spring	Free Length	41.7 to 42.2 mm 1.6417 to 1.6614 in.	41.2 mm 1.6220 in.
	Setting Load / Setting Length	117.6 N / 35.0 mm 12.0 kgf / 35.0 mm 26.4 lbs / 1.3780 in.	100.0 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbs /1.3780 in.
	Tilt	–	1.0 mm 0.039 in.
Rocker Arm Shaft to Rocker Arm	Oil Clearance	0.016 to 0.045 mm 0.00063 to 0.00177 in.	0.10 mm 0.0039 in.
Rocker Arm Shaft	O.D.	13.973 to 13.984 mm 0.55012 to 0.55055 in.	–
Rocker Arm	I.D.	14.000 to 14.018 mm 0.55118 to 0.55189 in.	–
Push Rod	Alignment	–	0.25 mm 0.0098 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Tappet to Tappet Guide	Oil Clearance	0.020 to 0.062 mm 0.00079 to 0.00244 in.	0.07 mm 0.0028 in.
Tappet	O.D.	23.959 to 23.980 mm 0.94327 to 0.94410 in.	–
Tappet Guide	I.D.	24.000 to 24.021 mm 0.94488 to 0.94571 in.	–
Timing Gear Crank Gear to Idle Gear	Backlash	0.0415 to 0.1122 mm 0.00163 to 0.00442 in.	0.15 mm 0.0059 in.
Idle Gear to Cam Gear	Backlash	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
Idle Gear to Injection Pump Gear	Backlash	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
Crank Gear to Oil Pump Gear	Backlash	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.	0.15 mm 0.0059 in.
Idle Gear	Side Clearance	0.12 to 0.48 mm 0.0047 to 0.0189 in.	0.90 mm 0.0354 in.
Idle Gear Shaft to Idle Gear Bushing	Oil Clearance	0.025 to 0.066 mm 0.00098 to 0.00260 in.	0.10 mm 0.0039 in.
Idle Gear Shaft	O.D.	37.959 to 37.975 mm 1.49445 to 1.49508 in.	–
Idle Gear Bushing	I.D.	38.000 to 38.025 mm 1.49606 to 1.49705 in.	–
Camshaft	Side Clearance	0.07 to 0.22 mm 0.0028 to 0.0087 in.	0.30 mm 0.0118 in.
Camshaft	Alignment	–	0.01 mm 0.0004 in.
Cam **[D1403-E2B]** **[D1503-E2B]** **[F2803-E2B]**	Height (Intake)	33.263 to 33.283 mm 1.3096 to 1.3104 in.	33.22 mm 1.3079 in.
	Height (Exhaust)	33.463 to 33.483 mm 1.3174 to 1.3182 in.	33.42 mm 1.3157 in.
Cam **[D1703-E2B]** **[V1903-E2B]** **[V2203-E2B]**	Height (Intake)	33.463 to 33.483 mm 1.3174 to 1.3182 in.	33.42 mm 1.3157 in.
	Height (Exhaust)	33.463 to 33.483 mm 1.3174 to 1.3182 in.	33.42 mm 1.3157 in.
Cam **[V2003-TE2B]**	Height (Intake)	33.890 to 33.910 mm 1.3343 to 1.3350 in.	33.85 mm 1.3327 in.
	Height (Exhaust)	33.463 to 33.483 mm 1.3174 to 1.3182 in.	33.42 mm 1.3157 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Camshaft Journal to Cylinder Block Bore	Oil Clearance	0.050 to 0.091 mm 0.00197 to 0.00358 in.	0.15 mm 0.0059 in.
Camshaft Journal	O.D.	39.934 to 39.950 mm 1.57221 to 1.57284 in.	–
Cylinder Block Bore	I.D.	40.000 to 40.025 mm 1.57480 to 1.57579 in.	–
Piston Pin Bore	I.D.	25.000 to 25.013 mm 0.98425 to 0.98476 in.	25.05 mm 0.9862 in.
Second Ring to Ring Groove **[D1403/D1503/D1703/V1903/V2203/ F2803-E2B]**	Clearance	0.093 to 0.120 mm 0.0037 to 0.0047 in.	0.20 mm 0.0079 in.
Second Ring to Ring Groove **[V2003-TE2B]**	Clearance	0.093 to 0.123 mm 0.0037 to 0.0048 in.	0.20 mm 0.0079 in.
Oil Ring to Ring Groove	Clearance	0.020 to 0.052 mm 0.0008 to 0.0020 in.	0.15 mm 0.0059 in.
Top Ring	Ring Gap	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
Second Ring	Ring Gap	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
Oil Ring	Ring Gap	0.25 to 0.45 mm 0.0098 to 0.0177 in.	1.25 mm 0.0492 in.
Connecting Rod	Alignment	–	0.05 mm 0.0020 in.
Piston Pin to Small End Bushing	Oil Clearance	0.014 to 0.038 mm 0.00055 to 0.00150 in.	0.15 mm 0.0059 in.
Piston Pin	O.D.	25.002 to 25.011 mm 0.98433 to 0.98469 in.	–
Small End Bushing	I.D.	25.025 to 25.040 mm 0.98524 to 0.98583 in.	–
Crankshaft	Alignment	–	0.02 mm 0.00079 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Crankshaft Journal to Crankshaft Bearing 1 **[D1403/D1503/D1703/V1903/V2003-T/ V2203-E2B]**	Oil Clearance	0.040 to 0.118 mm 0.00157 to 0.00465 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.35910 to 2.35984 in.	–
Crankshaft Bearing 1	I.D.	59.980 to 60.039 mm 2.36142 to 2.36374 in.	–
Crankshaft Journal to Crankshaft Bearing 1 **[F2803-E2B]**	Oil Clearance	0.040 to 0.118 mm 0.00157 to 0.00465 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	51.921 to 51.940 mm 2.04413 to 2.04488 in.	–
Crankshaft Bearing 1	I.D.	51.980 to 52.039 mm 2.04646 to 2.04878 in.	–
Crankshaft Journal to Crankshaft Bearing 2 **[D1403/D1503/D1703/V1903/V2003-T/ V2203-E2B]**	Oil Clearance	0.040 to 0.104 mm 0.00157 to 0.00409 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.35910 to 2.35984 in.	–
Crankshaft Bearing 2	I.D.	59.980 to 60.025 mm 2.36142 to 2.36319 in.	–
Crankshaft Journal to Crankshaft Bearing 2 **[F2803-E2B]**	Oil Clearance	0.040 to 0.104 mm 0.00157 to 0.00409 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	51.921 to 51.940 mm 2.04413 to 2.04488 in.	–
Crankshaft Bearing 2	I.D.	51.980 to 52.025 mm 2.04646 to 2.04823 in.	–
Crankpin to Crankpin Bearing	Oil Clearance	0.025 to 0.087 mm 0.00098 to 0.00343 in.	0.20 mm 0.0079 in.
Crankpin	O.D.	46.959 to 46.975 mm 1.84878 to 1.84941 in.	–
Crankpin Bearing	I.D.	47.000 to 47.046 mm 1.85039 to 1.85221 in.	–

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Crankshaft **[D1403/D1503/D1703/V1903/V2003-T/ V2203-E2B]**	Side Clearance	0.15 to 0.31 mm 0.0059 to 0.0122 in.	0.50 mm 0.0197 in.
Crankshaft **[F2803-E2B]**	Side Clearance	0.15 to 0.35 mm 0.0059 to 0.0138 in.	0.50 mm 0.0197 in.
Cylinder Bore (Standard) **[D1403-E2B] [V1903-E2B]**	I.D.	80.000 to 80.022 mm 3.14961 to 3.15047 in.	80.150 mm 3.15551 in.
Cylinder Bore (Standard) **[D1503-E2B] [V2003-TE2B]**	I.D.	83.000 to 83.022 mm 3.26772 to 3.26858 in.	83.150 mm 3.27362 in.
Cylinder Bore (Standard) **[D1703-E2B] [V2203-E2B] [F2803-E2B]**	I.D.	87.000 to 87.022 mm 3.42520 to 3.42606 in.	87.150 mm 3.43110 in.
Cylinder Bore (Oversize) **[D1403-E2B] [V1903-E2B]**	I.D.	80.500 to 80.522 mm 3.16929 to 3.17016 in.	80.650 mm 3.17520 in.
Cylinder Bore (Oversize) **[D1503-E2B] [V2003-TE2B]**	I.D.	83.500 to 83.522 mm 3.28740 to 3.28827 in.	83.650 mm 3.29331 in.
Cylinder Bore (Oversize) **[D1703-E2B] [V2203-E2B] [F2803-E2B]**	I.D.	87.500 to 87.522 mm 3.44488 to 3.44575 in.	87.650 mm 3.45079 in.

W1013874

LUBRICATING SYSTEM

Engine Oil Pressure	At Idle Speed	More than 98 kPa 1.0 kgf/cm^2 14 psi	49 kPa 0.5 kgf/cm^2 7 psi
	At Rated Speed	294 to 441 kPa 3.0 to 4.5 kgf/cm^2 42.7 to 64.0 psi	245 kPa 2.5 kgf/cm^2 35.6 psi
Engine Oil Pressure Switch	Working Pressure	49 kPa 0.5 kgf/cm^2 7 psi	–
Inner Rotor to Outer Rotor	Clearance	0.03 to 0.14 mm 0.0012 to 0.0055 in.	0.20 mm 0.0079 in.
Outer Rotor to Pump Body	Clearance	0.11 to 0.19 mm 0.0043 to 0.0075 in.	0.25 mm 0.0098 in.
Inner Rotor to Cover	Clearance	0.105 to 0.150 mm 0.00413 to 0.00591 in.	0.20 mm 0.0079 in.

W1013973

COOLING SYSTEM

Item		Factory Specification	Allowable Limit
Fan Belt	Tension	7.0 to 9.0 mm (0.28 to 0.35 in.) deflection at 98 N (10 kgf, 22 lbs) of force	–
Thermostat	Valve Opening Temperature (At Beginning)	69.5 to 72.5 °C 157.1 to 162.5 °F	–
	Valve Opening Temperature (Opened Completely)	85 °C 185 °F	–
Radiator	Water Tightness	No leak at 137 kPa 1.4 kgf/cm^2 20 psi	–
Radiator Cap	Pressure Falling Time	More than 10 seconds for pressure fall from 88 to 59 kPa from 0.9 to 0.6 kgf/cm^2 from 13 to 9 psi	–

W1013874

FUEL SYSTEM

Injection Pump **[D1403/D1503/D1703/V1903/V2003-T/ V2203-E2B]**	Injection Timing	0.297 to 0.331 rad (17 to 19 °) before T.D.C.	–
Injection Pump **[F2803-E2B]**	Injection Timing	0.314 to 0.349 rad (18 to 20 °) before T.D.C.	–
Pump Element	Fuel Tightness	–	13.73 MPa 140 kgf/cm^2 1991 psi
Delivery Valve	Fuel Tightness	10 seconds 13.73 → 12.75 MPa 140 → 130 kgf/cm^2 1991 → 1849 psi	5 seconds 13.73 → 12.75 MPa 140 → 130 kgf/cm^2 1991 → 1849 psi
Injection Nozzle	Injection Pressure	13.73 to 14.71 MPa 140 to 150 kgf/cm^2 1991 to 2134 psi	–
Injection Nozzle Valve Seat	Valve Seat Tightness	When the pressure is 12.75 MPa (130 kgf/cm^2, 1849 psi), the valve seat must be fuel tightness.	–

W1013973

ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Starter			
Commutator	O.D.	30.0 mm 1.181 in.	29.0 mm 1.142 in.
Mica	Under Cut	0.45 to 0.75 mm 0.0177 to 0.0295 in.	0.20 mm 0.0079 in.
Brush	Length	15.0 mm 0.591 in.	11.0 mm 0.433 in.
Alternator	No-load voltage	More than 13.5 V	–
Stator	Resistance	Less than 1.0 Ω	–
Rotor	Resistance	2.9 Ω	–
Slip Ring	O.D.	14.4 mm 0.567 in.	14.0 mm 0.551 in.
Brush	Length	10.5 mm 0.413 in.	8.4 mm 0.331 in.
Glow Plug	Resistance	Approx. 0.9 Ω	–

W1013874

3. TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and the proper torque.

[1] TIGHTENING TORQUES FOR GENERAL USE SCREWS, BOLTS AND NUTS

When the tightening torques are not specified, tighten the screws, bolts and nuts according to the table below.

Grade / Nominal Diameter / Unit	Standard Screw and Bolt 4			Special Screw and Bolt 7		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

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Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

Punched number	Screw and bolt material grade
None or 4	Standard screw and bolt SS41, S20C
7	Special screw and bolt S43C, S48C (Refined)

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[2] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS

■ **NOTE**

- **For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.**
- **The letter "M" in Size x Pitch means that the screw, bolt or nut dimension stands for metric. The size is the nominal outside diameter in mm of the threads. The pitch is the nominal distance in mm between two threads.**

Item	Size x Pitch	N·m	kgf·m	ft-lbs
*Cylinder head cover screw	M6 x 1.0	6.9 to 11.3	0.7 to 1.15	5.1 to 8.32
*Cylinder head cover cap nut	M8 x 1.25	6.9 to 8.8	0.7 to 0.9	5.1 to 6.5
Injection pipe retaining nut	M12 x 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
Nozzle holder assembly	M20 x 1.5	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
Overflow pipe assembly retaining nut	M12 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Glow plug	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
*Rocker arm bracket screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
*Rocker arm bracket nut	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
*Cylinder head screw	M11 x 1.25	93.2 to 98.1	9.5 to 10.0	68.7 to 72.3
Fan drive pulley mounting nut	M30 x 1.5	137.3 to 156.9	14.0 to 16.0	101.3 to 115.7
Fan drive pulley screw	M16 x 1.5	313.8 to 333.4	32.0 to 34.0	231.5 to 245.9
Camshaft set screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
*Connecting rod screw	M8 x 1.0	44.1 to 49.0	4.5 to 5.0	32.5 to 36.2
*Flywheel screw	M12 x 1.25	98.1 to 107.9	10.0 to 11.0	72.3 to 79.6
*Bearing case cover screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
*Main bearing case screw 2	M10 x 1.25	68.6 to 73.5	7.0 to 7.5	50.6 to 54.2
*Main bearing case screw 1	M9 x 1.25	46.1 to 51.0	4.7 to 5.2	34.0 to 37.6
Oil pressure switch	R 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Nozzle holder	–	34.3 to 39.2	3.5 to 4.0	25.3 to 28.9
Starter's terminal **B** mounting nut	M8	5.9 to 11.8	0.6 to 1.2	4.3 to 8.7
Alternator's pulley nut	–	58.3 to 78.9	5.95 to 8.05	43.0 to 58.2

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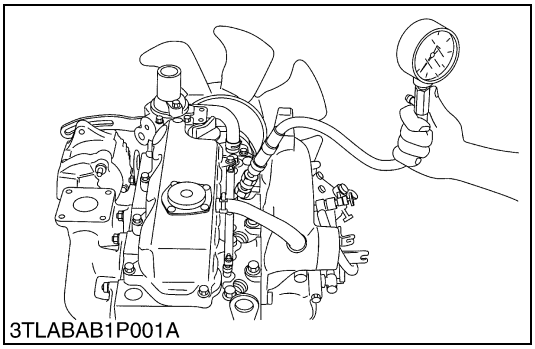
4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body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Compression Pressure

1. Run the engine until it is warmed up.
2. Stop the engine and disconnect the **2P** connector from the stop solenoid in order not to inject fuel.
3. Remove the air cleaner, the muffler and all injection nozzles.
4. Set a compression tester (Code No. 07909-30208) with the adaptor to the nozzle hole.
5. Keep the engine stop lever at **"Stop Position"**.
6. While cranking the engine with the starter, measure the compression pressure.
7. Repeat steps 4 through 6 for each cylinder.
8. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the nozzle hole and measure the compression pressure again.
9. If the compression pressure is still less than the allowable limit, check the top clearance, valve and cylinder head.
10. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

■ **NOTE**

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for performing this test.**
- **Variances in cylinder compression values should be under 10 %.**

Compression pressure	Factory spec.	3.53 to 3.72 MPa 36 to 38 kgf/cm^2 512 to 540 psi
	Allowable limit	2.55 MPa 26 kgf/cm^2 370 psi

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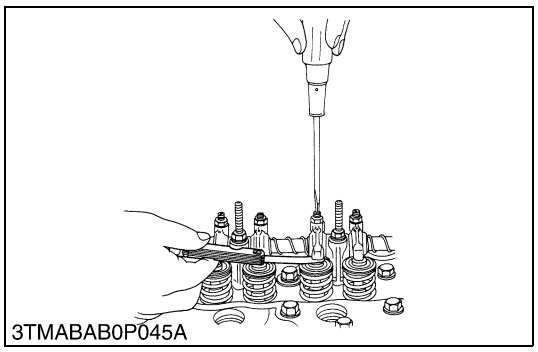
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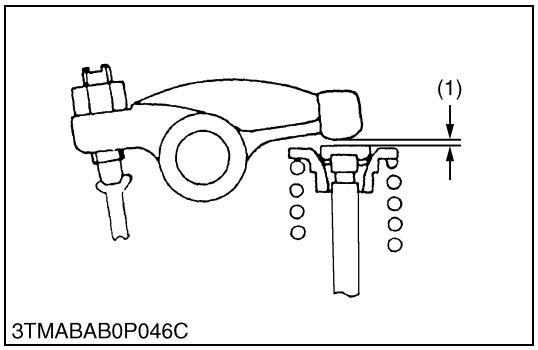

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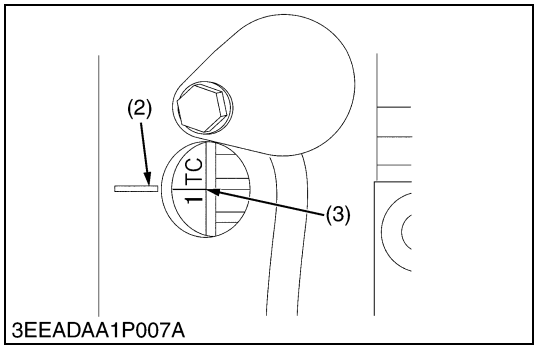

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Valve Clearance

■ **IMPORTANT**

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the head cover.
2. Align the **"1TC"** mark line (3) on the flywheel and projection (2) on the housing so that the No.1 piston comes to the compression or overlap top dead center.
3. Check the following valve clearance (1) marked with "☆" using a feeler gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory spec.	0.18 to 0.22 mm 0.0071 to 0.0087 in.

■ **NOTE**

- **The "TC" marking line on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.**
- **No. 1 piston comes to the top dead center position when the "TC" marking is aligned with the projection (2) in the window on flywheel-housing. Turn the flywheel 0.26 rad (15°) clockwise and counterclockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance (1). (The piston is at the top dead center when both the IN. and EX. valves do not move; it is at the overlap position when both the valves move.)**
- **Finally turn the flywheel 6.28 rad (360°) and align the "TC" marking and the projection (2) perfectly. Adjust all the other valve clearance as required.**
- **After turning the flywheel counterclockwise twice or three times, recheck the valve clearance (1).**
- **After adjusting the valve clearance (1), firmly tighten the lock nut of the adjusting screw.**

Adjustable cylinder location of piston \ Valve arrangement		D1403-E2B D1503-E2B D1703-E2B		V1903-E2B V2203-E2B V2003-TE2B		F2803-E2B	
		IN.	EX.	IN.	EX.	IN.	EX.
When No. 1 piston comes to compression top dead center	No. 1	☆	☆	☆	☆	☆	☆
	No. 2		☆	☆		☆	
	No. 3	☆			☆		☆
	No. 4	–	–				
	No. 5	–	–	–	–		
When No. 1 piston comes to overlap position	No. 1						
	No. 2	☆			☆		☆
	No. 3		☆	☆		☆	
	No. 4	–	–	☆	☆	☆	☆
	No. 5	–	–	–	–	☆	☆

(1) Valve Clearance
(2) Projection
(3) TC Mark Line

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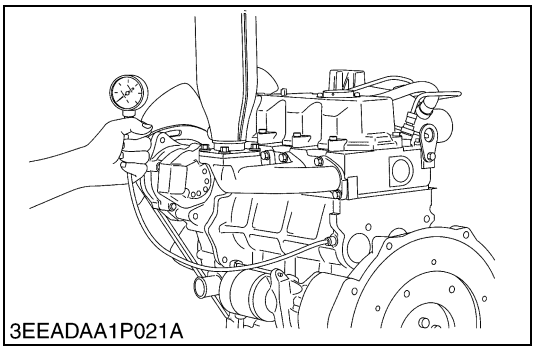
(2) Lubricating System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Engine Oil Pressure

1. Remove the engine oil pressure switch, and set an oil pressure tester (Code No.: 07916-32032). (Adaptor screw size : PT 1/8)
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.

- Engine oil insufficient.
- Oil pump defective
- Oil strainer clogged
- Oil filter cartridge clogged
- Oil gallery clogged
- Excessive oil clearance
- Foreign matter in the relief valve

Engine oil pressure	At idle speed	Factory spec.	More than 98 kPa 1.0 kgf/cm^2 14 psi
		Allowable limit	49 kPa 0.5 kgf/cm^2 7 psi
	At rated speed	Factory spec.	294 to 441 kPa 3.0 to 4.5 kgf/cm^2 42.7 to 64.0 psi
		Allowable limit	245 kPa 2.5 kgf/cm^2 35.6 psi

(When reassembling)

- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

Tightening torque	Oil pressure switch	14.7 to 19.6 N·m 1.5 to 2.0 kgf·m 10.8 to 14.5 ft-lbs

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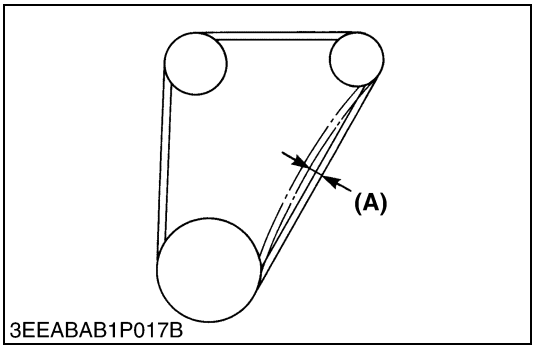
(3) Cooling System



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Fan Belt Tension

1. Measure the deflection **(A)**, depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection **(A)**	Factory spec.	7.0 to 9.0 mm 0.28 to 0.35 in.

(A) Deflection

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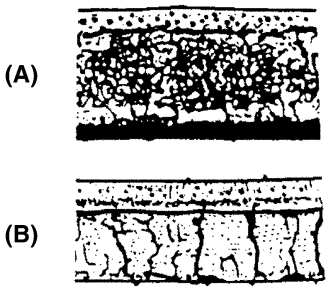

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Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(A) Good **(B) Bad**

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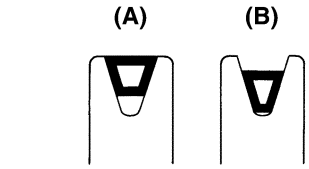

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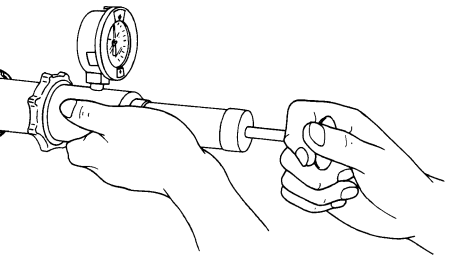
CAUTION

- **When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.**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Radiator Cap Air Leakage

1. Set a radiator tester and an adaptor on the radiator cap.
2. Apply the specified pressure 88 kPa (0.9 kgf/cm^2, 13 psi), and measure the time for the pressure to fall to 59 kPa (0.6 kgf/cm^2, 9 psi).
3. If the measurement is less than the factory specification, replace the radiator cap.

Pressure falling time	Factory spec.	More than 10 seconds for pressure fall from 88 to 59 kPa (from 0.9 to 0.6 kgf/cm^2, from 13 to 9 psi)

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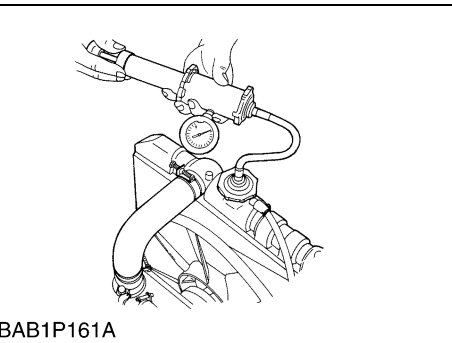
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Radiator Water Leakage

1. Pour a specified amount of water into the radiator.
2. Set a radiator tester and an adaptor and raise the water pressure to the specified pressure.
3. Check the radiator for water leaks.
4. For water leak from the pinhole, replace the radiator or repair with the radiator cement. When water leak is excessive, replace the radiator.

Radiator water leakage test pressure	Factory spec.	No leak at 137 kPa 1.4 kgf/cm^2 20 psi

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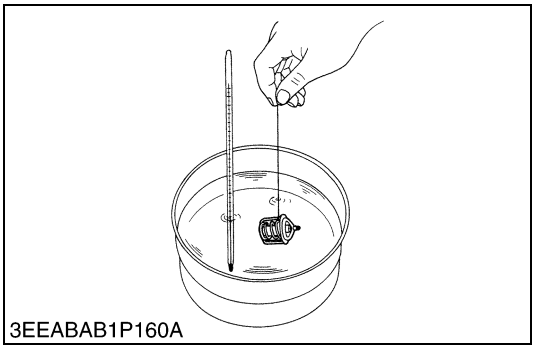
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Thermostat Valve Opening Temperature

1. Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
2. Heating the water gradually, read the temperature when the valve opens and leaves the string.
3. Continue heating and read the temperature when the valve opens approx. 6 mm (0.236 in.).
4. If the measurement is not within the factory specifications, replace the thermostat.

Thermostat's valve opening temperature	Factory spec.	69.5 to 72.5 °C 157.1 to 162.5 °F
Temperature at which thermostat completely opens	Factory spec.	85 °C 185 °F

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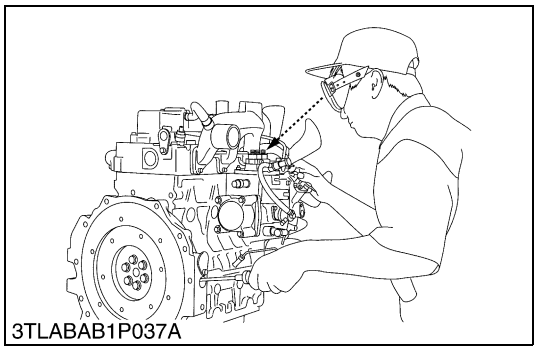
(4) Fuel System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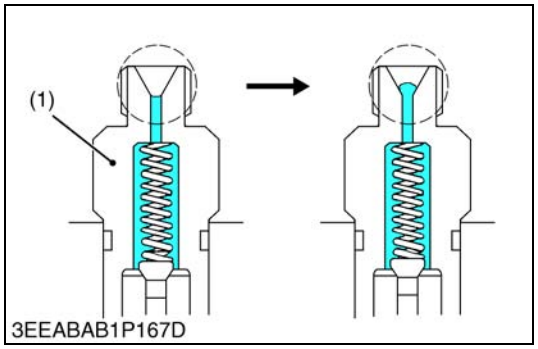

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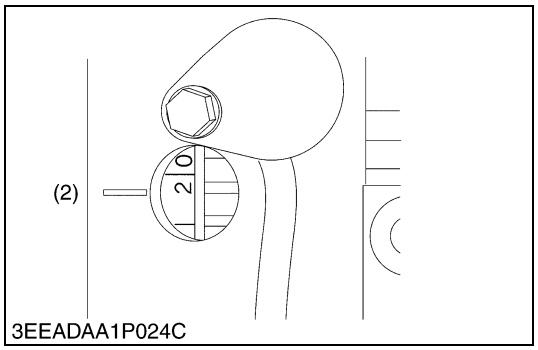

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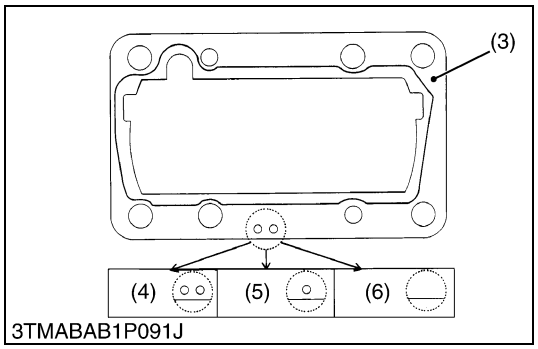

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Injection Timing

1. Remove the injection pipes and nozzle.
2. Set the speed control lever to maximum fuel discharge position.

(Reference)

- Turn the flywheel with screwdriver.

3. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up to the hole of the delivery valve holder for 1st cylinder.
4. Turn the flywheel further and stop turning when the fuel begins to flow over, to get the present injection timing.
5. (The flywheel has mark 1TC and four lines indicating every 0.087 rad (5 °) of crank angle from 0.175 rad (10 °) to 0.436 rad (25 °) before mark 1TC) Calculate the angle which the center of the window points out. If the calculation differs from specified injection timing, add or remove the shim to adjust.

[D1403/D1503/D1703/V1903/V2003-T/V2203-E2B]

Injection timing	Factory spec.	0.279 to 0.331 rad (17 to 19 °) before T.D.C.

[F2803-E2B]

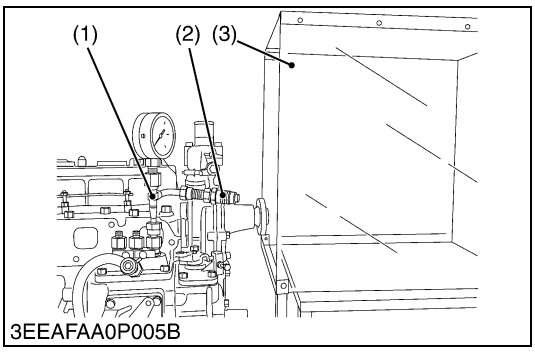
Injection timing	Factory spec.	0.314 to 0.349 rad (18 to 20 °) before T.D.C.

■ **NOTE**

- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Shims are available in thickness of 0.20 mm, 0.25 mm and 0.30 mm. Combine these shims for adjustments.**
- **Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5 °).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

(1) Delivery Valve Holder
(2) Timing Mark
(3) Shim (Soft Metal Gasket Shim)
(4) 2-holes : 0.20 mm (Shim)
(5) 1-hole : 0.25 mm (Shim)
(6) Without hole : 0.30 mm (Shim)

W1045339



Fuel Tightness of Pump Element

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

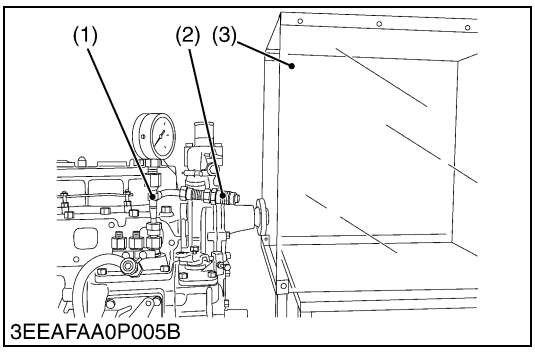
Fuel tightness of pump element	Allowable limit	13.73 MPa 140 kgf/cm^2 1991 psi

■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

W1017430



Fuel Tightness of Delivery Valve

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hands and raise the pressure to approx. 13.73 MPa (140 kgf/cm^2, 1991 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 13.73 to 12.75 MPa (from 140 to 130 kgf/cm^2, from 1991 to 1849 psi).
8. Measure the time needed to decrease the pressure from 13.73 to 12.75 MPa (140 to 130 kgf/cm^2, 1991 to 1849 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of delivery valve	Factory spec.	10 seconds 13.73 → 12.75 MPa 140 → 130 kgf/cm^2 1991 → 1849 psi
	Allowable limit	5 seconds 13.73 → 12.75 MPa 140 → 130 kgf/cm^2 1991 → 1849 psi

■ **NOTE**

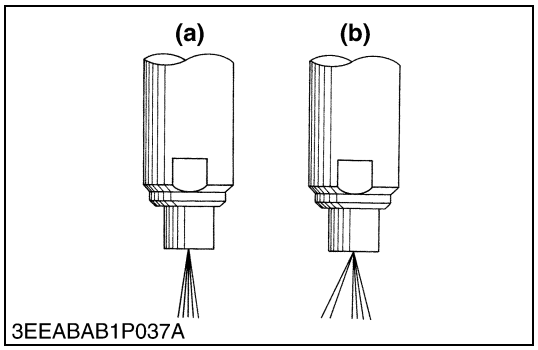
- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

W1017786

⚠ CAUTION

- **Check the nozzle injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.**
- **If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.**



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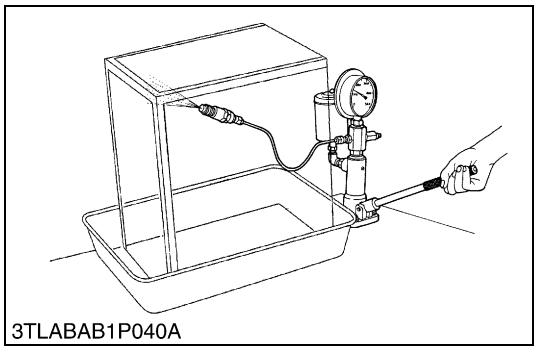
Nozzle Spraying Condition

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the nozzle piece.

(a) Good **(b) Bad**

W10181310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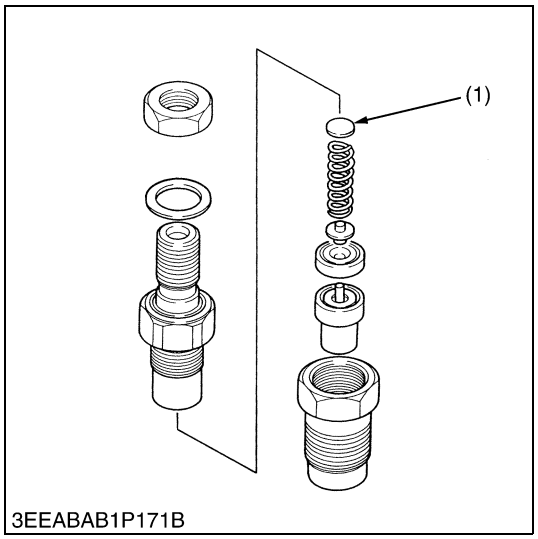
Fuel Injection Pressure

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (1) in the nozzle holder to adjust it.

(Reference)

- Pressure variation with 0.025 mm (0.0010 in.) difference of adjusting washer thickness.
  Approx. 588 kPa (6.0 kgf/cm^2, 85 psi)

Fuel injection pressure	Factory spec.	13.73 to 14.71 MPa 140 to 150 kgf/cm^2 1991 to 2134 psi



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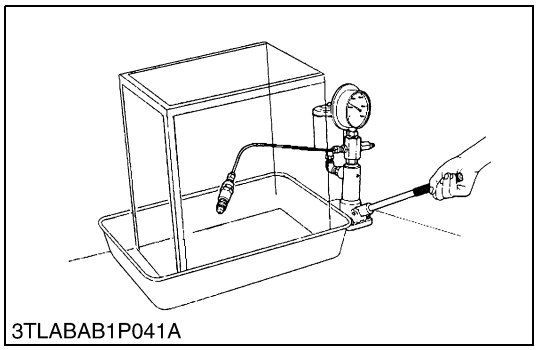
(1) Adjusting Washer

W10182100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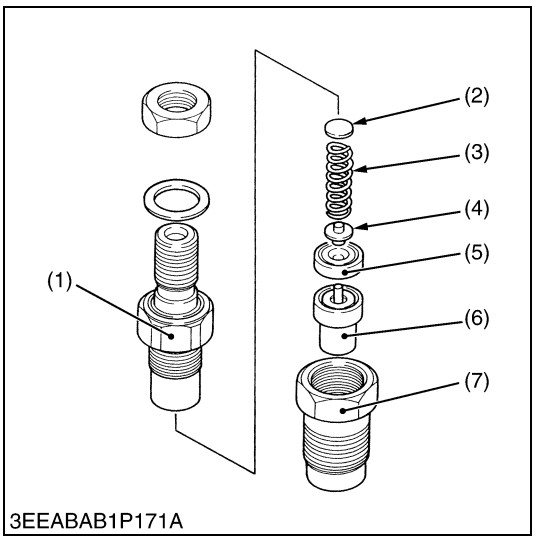
Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130 kgf/cm^2, 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.

Valve seat tightness	Factory spec.	No fuel leak at 12.75 MPa 130 kgf/cm^2 1849 psi

W10183690



Nozzle Holder

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.
- After assembling the nozzle, be sure to adjust the fuel injection pressure.

Tightening torque	Nozzle holder	34.3 to 39.2 N·m 3.5 to 4.0 kgf·m 25.3 to 28.9 ft-lbs
	Overflow pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Nozzle holder assembly	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs

(1) Nozzle Holder
(2) Adjusting Washer
(3) Nozzle Spring
(4) Push Rod
(5) Distance Piece
(6) Nozzle Piece
(7) Nozzle Retaining Nut

W1018491

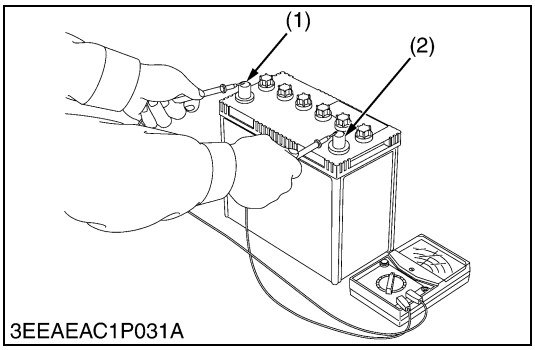
(5) Electrical System

CAUTION

- **To avoid accidental short circuit, be sure to attach the positive cable to the positive terminal before the negative cable is attached to the negative terminal.**
- **Never remove the battery cap while the engine is running.**
- **Keep electrolyte away from eyes, hands and clothes. If you are spattered with it, wash it away completely with water immediately.**
- **Keep open sparks and flames away from the battery at all times. Hydrogen gas mixed with oxygen becomes very explosive.**

IMPORTANT

- **If the machine is to be operated for a short time without battery (using a slave battery for starting), use additional current (lights) while engine is running and insulate terminal of battery. If this advice is disregarded, damage to alternator and regulator may result.**



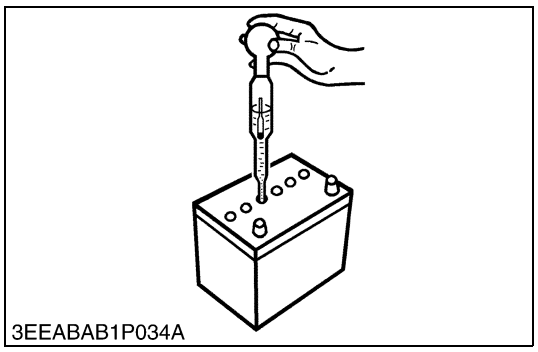
Battery Voltage

1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

Battery voltage	Factory spec.	More than 12 V

(1) Positive Terminal
(2) Negative Terminal

W10125620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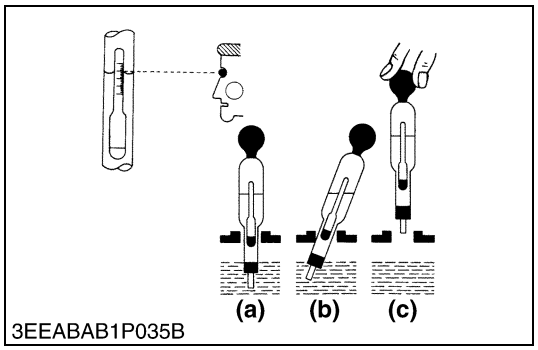

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Battery Specific Gravity

1. Check the specific gravity of the electrolyte in each cell with a hydrometer.
2. When the electrolyte temperature differs from that at which the hydrometer was calibrated, correct the specific gravity reading following the formula mentioned in **(Reference)**.
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity differs between any two cells by more than 0.05, replace the battery.

■ **NOTE**

- **Hold the hydrometer tube vertical without removing it from the electrolyte.**
- **Do not suck too much electrolyte into the tube.**
- **Allow the float to move freely and hold the hydrometer at eye level.**
- **The hydrometer reading must be taken at the highest electrolyte level.**

(Reference)

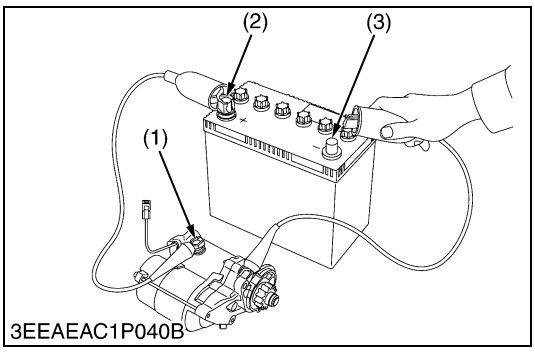
- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 °C (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 °C (0.0004 with a decrease of 1 °F).
  Therefore, using 20 °C (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :
  - Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature : 20 °C)
  - Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature : 68 °F)

Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

(a) Good
(b) Bad
(c) Bad

W1019017



Motor Test

CAUTION

- **Secure the starter to prevent it from jumping up and down while testing the motor.**

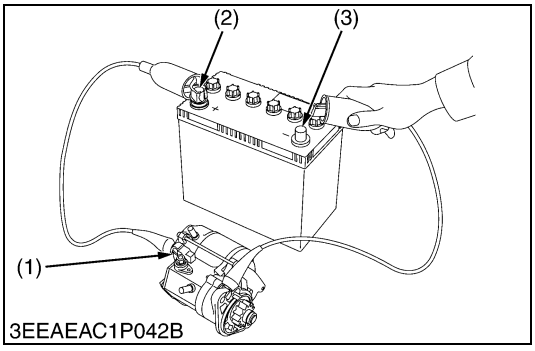
1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **C** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
7. If the motor does not run, starter is failure.
   Repair or replace the starter.

NOTE

- **B terminal : It is the terminal which connects the cable from the battery to the starter.**
- **C terminal : It is the terminal which connects the cable from the motor to the magnet switch.**

(1) **C** Terminal
(2) Positive Terminal
(3) Negative Terminal

W1019297



Magnetic Switch Test

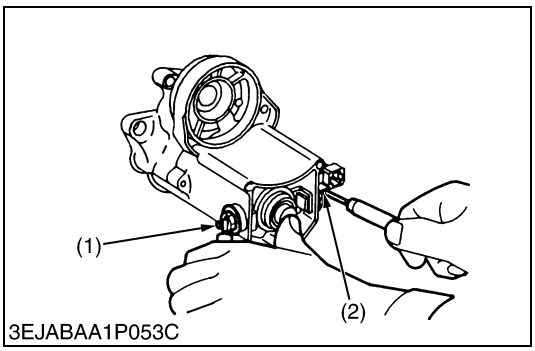
1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **S** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
7. If the pinion gear does not pop out, the magnetic switch is failure.
   Repair or replace the starter.

NOTE

- **B terminal : It is the terminal which connects the cable from the battery to the starter.**
- **S terminal : It is the terminal which connects the cable from the starter switch to the magnet switch.**

(1) **S** Terminal
(2) Positive Terminal
(3) Negative Terminal

0000010743E

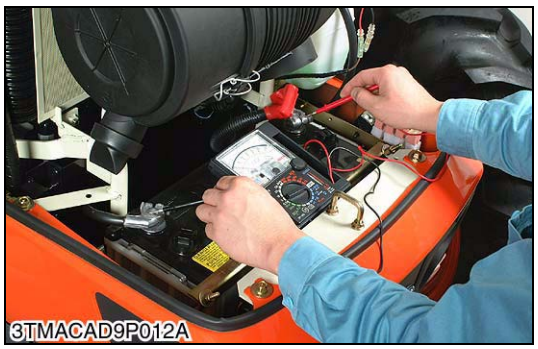


Magnet Switch Continuity Test

1. Check the continuity across the **C** terminal (1) and the **B** terminal (2) with a circuit tester, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the magnet switch.

(1) **C** Terminal
(2) **B** Terminal

0000010771E



Alternator on Unit Test

(Before testing)

- Before alternator on unit test, check the battery terminal connections, circuit connection, fan belt tension, charging indicator lamp, fuses on the circuit, and abnormal noise from the alternator.
- Prepare full charged battery for the test.

■ **NOTE**

- **Be careful not to touch the rotating engine parts while engine is running.**
  Keep safety distance from the engine rotating parts.

1. Start the engine.
2. When the engine is operating measure the voltage between two battery terminals. If the voltage is between 13.8 V and 14.8 V, the alternator is operating normally.
3. If the results of alternator on unit test are not within the specifications, disassemble the alternator and check the each component part for finding out the failure. See the "DISASSEMBLING AND ASSEMBLING" and "SERVICING" for alternator.

Regulating voltage at no load	Factory spec.	13.8 to 14.8 V at 25 °C (77 °F)

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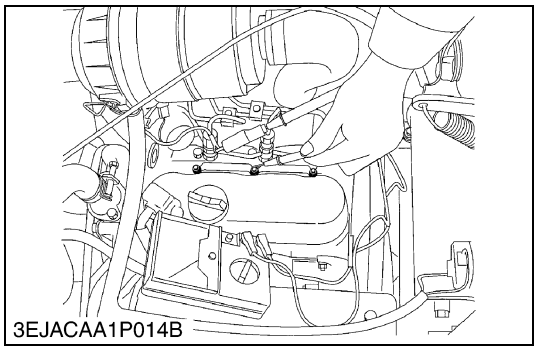

Glow Plug Lead Terminal Voltage

1. Turn the key switch to the "**GLOW** (or **PREHEAT**)" position, and measure the voltage with a circuit tester between the lead terminal and the engine body.
2. If the voltage differs from the battery voltage, the wiring harness or main switch is faulty.

Voltage	Main switch key at **GLOW** (or **PREHEAT**)	Approx. battery voltage

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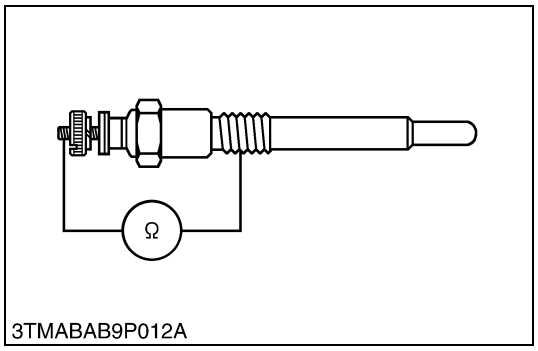


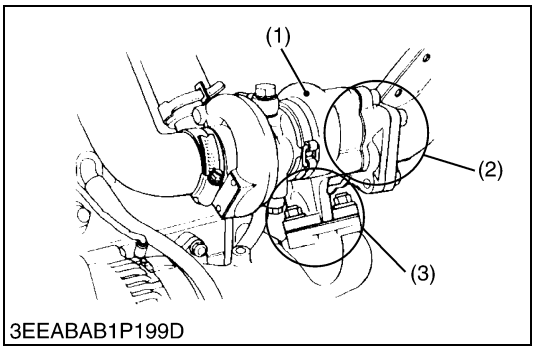
Glow Plug Continuity

1. Remove the glow plug.
2. Measure the resistance with a circuit tester between the glow plug terminal and the glow plug housing.
3. If the factory specification is not indicated, glow plug is faulty.

Resistance	Factory spec.	Approx. 0.9 Ω

0000010726E

(6) Turbocharger



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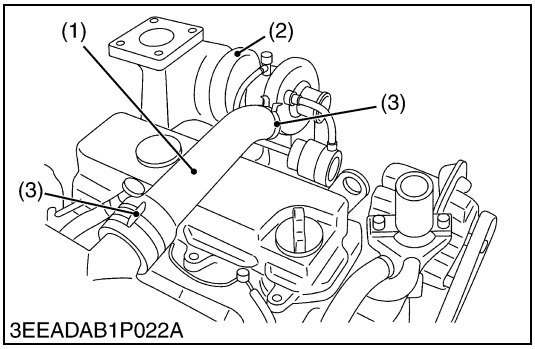
Turbine Side

1. Check the exhaust port (2) and inlet port (3) side of the turbine housing (1) to see if there is no exhaust gas leak.
2. If any gas leak is found, retighten the bolts and nuts or replace the gasket with new one.

(1) Turbine Housing
(2) Exhaust Port
(3) Inlet Port

W1069824



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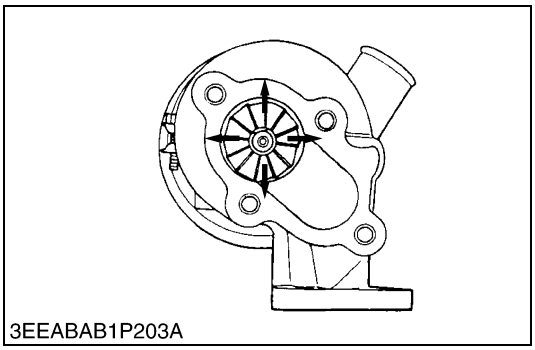
Compressor Side

1. Check the inlet hose (1) of the compressor cover (2) to see if there is no air leak.
2. Check for loose connections or cracks in the suction side of the intake hose.
3. If any air leak is found, change the clamp (3) and / or inlet hoses.

(1) Inlet Hose
(2) Compressor Cover
(3) Clamp

W1069939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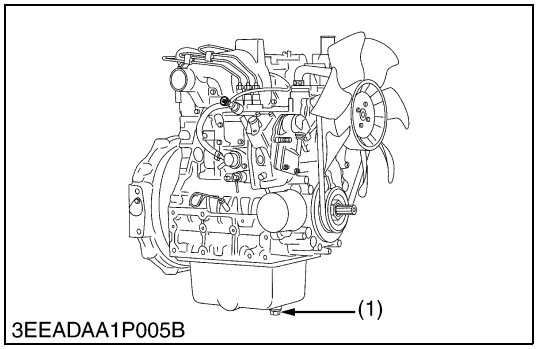
Radial Clearance

1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

W1077353

[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Oil and Coolant



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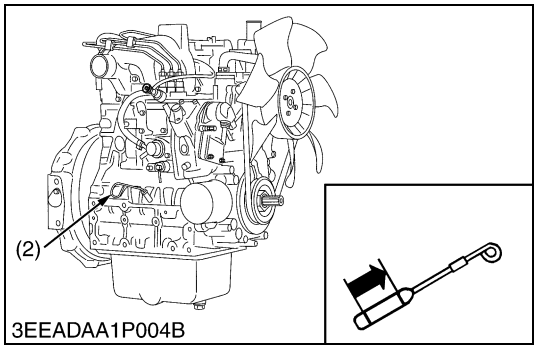

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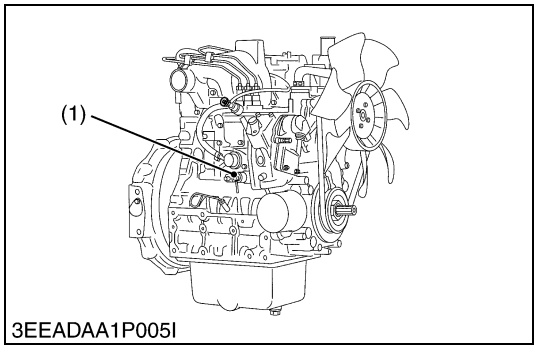

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Draining Engine Oil

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. Remove the drain plug (1) to drain oil.
4. After draining, screw in the drain plug.

(When refilling)

- Fill the engine oil up to the upper line on the dipstick (2).

■ **IMPORTANT**

- **Never mix two different types of oil.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

(1) Drain Plug (2) Dipstick

W1028998

Draining Coolant

⚠ CAUTION

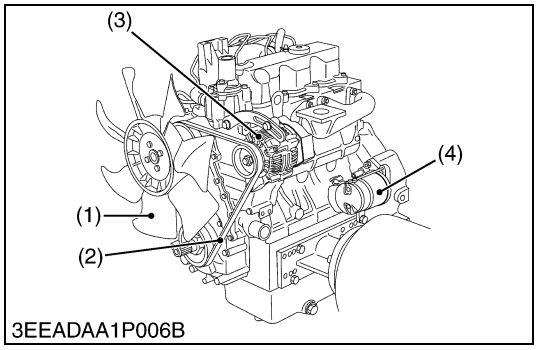
- **Never remove radiator cap while operating or immediately after stopping. Otherwise, hot water will spout out from the radiator. Wait for more than ten minutes to cool the radiator, before opening the cap.**

1. Prepare a bucket. Open the coolant drain cock.

(1) Coolant Drain Cock

W1029172

(2) External Components



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Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. Remove the fan (1), fan belt (2), alternator (3) and starter (4).

(When reassembling)

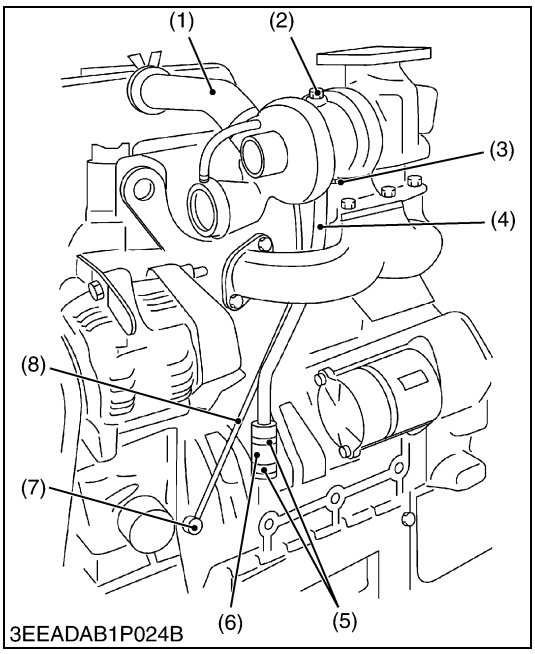
- Check to see that there are no cracks on the belt surface.

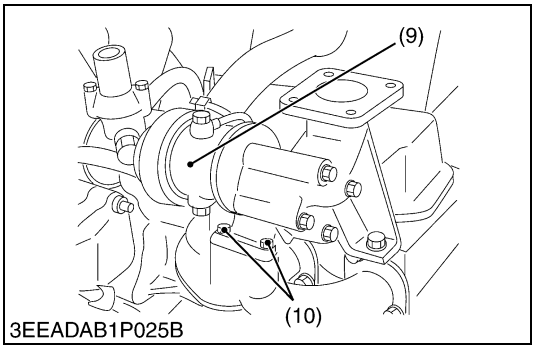
■ **IMPORTANT**

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**
- **Do not confuse the direction of the fan.**

(1) Fan (3) Alternator
(2) Fan Belt (4) Starter

W1060302





Turbocharger (equipped with Turbocharger Model)

CAUTION

- **While the engine is running and or just after it stops, the turbocharger is hot, be careful not to touch the turbocharger.**

NOTE

- **When detaching and attaching the turbocharger assembly, be very careful not to allow dust, dirt and other foreign matters in the oil pipes.**
- **When the turbocharger assembly has been replaced, pour fresh engine oil through the oil filter port of the turbocharger.**
- **Before starting the engine, make sure that the air cleaner is in position.**

1. Disconnect the inlet hose (1).
2. Remove the joint bolt (2), (7) and take off the oil pipe 1 (8).
3. Remove the bolts 1 (3) and release the clamp (5).
4. Disconnect the oil pipe 2 (4) and pipe 3 (6).
5. Remove the bolts 2 (10).
6. Take off the turbocharger assembly (9).

(When reassembling)

- Pour fresh engine oil through the oil filter port of the turbocharger.
- Replace the gaskets with new one.
- Be careful not to allow dust, dirt and other foreign matters in the oil pipes.

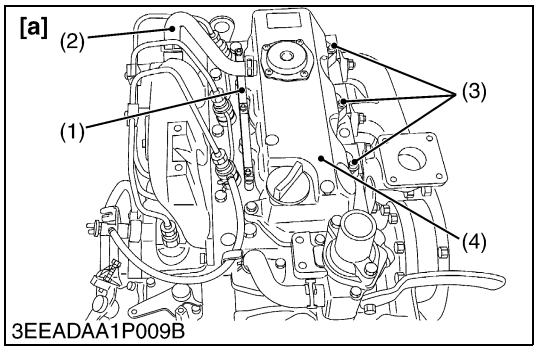
NOTE

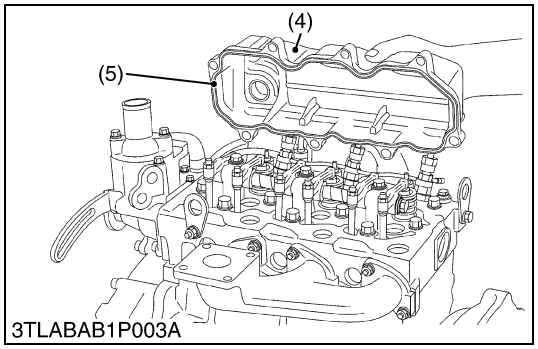
- **Tape or plug all opening to prevent foreign matters from damaging the oil cavities in the turbocharger.**

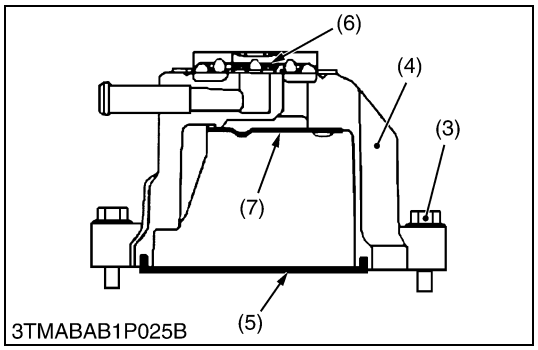
(1) Inlet Hose
(2) Joint Bolt
(3) Bolt 1
(4) Oil Pipe 2
(5) Clamp
(6) Oil Pipe 3
(7) Joint Bolt
(8) Oil Pipe 1
(9) Turbocharger Assembly
(10) Bolt 2

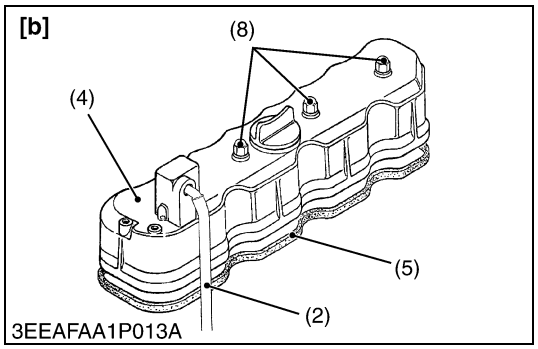
W1021474

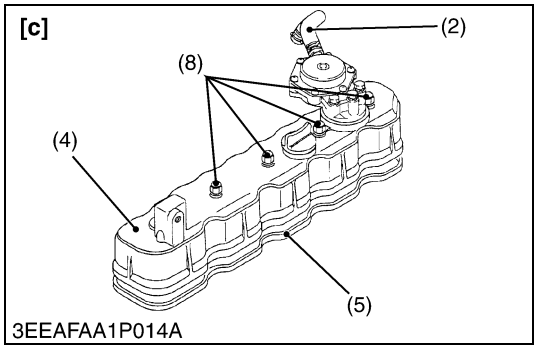
(3) Cylinder Head and Valves











Cylinder Head Cover

1. Remove the lead (1).
2. Remove the breather hose (2).
3. **[a] D1403/D1503/D1703/V1903/V2203-E2B**
   Remove the cylinder head cover screws (3).
   [b] V2003-TE2B / [c] F2803-E2B
   Remove the cylinder head cover cap nuts (8).
4. Remove the cylinder head cover (4).

(When reassembling)

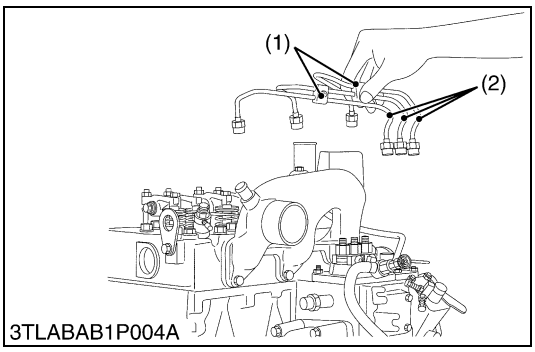
- Check to see if the cylinder head cover gasket is not defective.

Tightening torque	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Cylinder head cover cap nut	6.9 to 8.8 N·m 0.7 to 0.9 kgf·m 5.1 to 6.5 ft-lbs

(1) Lead
(2) Breather Hose
(3) Cylinder Head Cover Screw
(4) Cylinder Head Cover
(5) Cylinder Head Cover Gasket
(6) Breather Valve
(7) Plate
(8) Cylinder Head Cover Cap Nut

[a] D1403/D1503/D1703/V1903/V2203-E2B
[b] V2003-TE2B
[c] F2803-E2B

W1060460



Injection Pipes

1. Loosen the screws on the pipe clamps (1).
2. Detach the injection pipes (2).

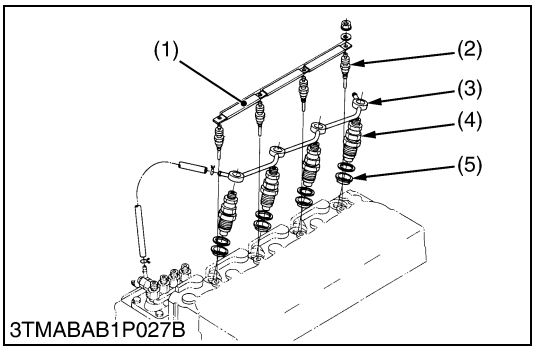
(When reassembling)

- Blow out dust inside the pipes.

Tightening torque	Injection pipe retaining nut	24.5 to 34.3 N·m 2.5 to 3.5 kgf·m 18.1 to 25.3 ft-lbs

(1) Pipe Clamp (2) Injection Pipe

W1060970



Nozzle Holder Assembly and Glow Plug

1. Remove the overflow pipe assembly (3).
2. Remove the nozzle holder assemblies (4) using a 21 mm deep socket wrench.
3. Remove the copper gasket and heat seal (5).
4. Remove the glow plugs (2).

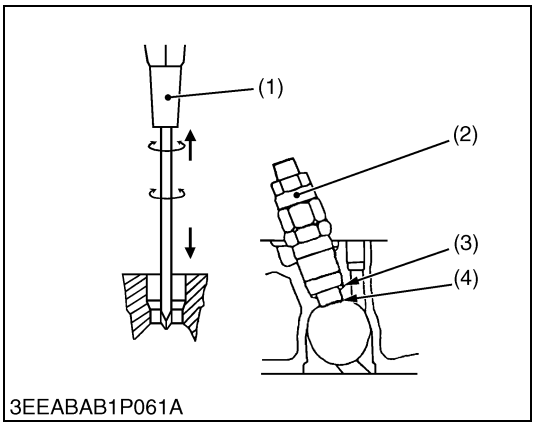
(When reassembling)

- Replace the copper gasket and heat seal with new one.

Tightening torque	Nozzle holder assembly	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs
	Overflow pipe assembly retaining screw	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Glow plug	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Lead
(2) Glow Plug
(3) Overflow Pipe Assembly
(4) Nozzle Holder Assembly
(5) Heat Seal

W1020917



Nozzle Heat Seal Service Removal Procedure

■ **IMPORTANT**

- **Use a plus (phillips head) screw driver (1) that has a diameter which is bigger than the heat seal hole (Approx. 6 mm (1/4 in.)).**

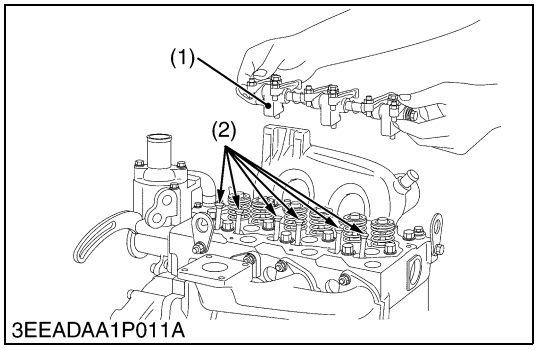
1. Drive screw driver (1) lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal (4) out together with the injection nozzle gasket (3).
4. If the heat seal drops, repeat the above procedure.

(When reassembling)

- Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.

(1) Plus Screw Driver
(2) Injection Nozzle
(3) Injection Nozzle Gasket
(4) Heat Seal

W1021255



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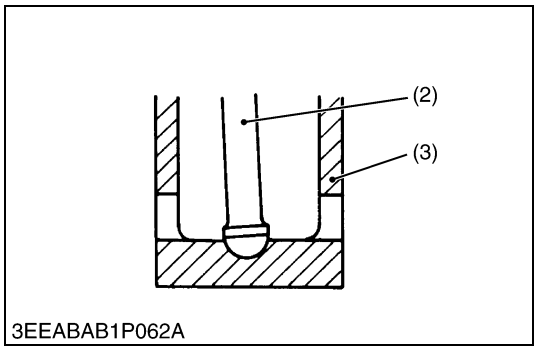

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Rocker Arm and Push Rod

1. Remove the rocker arm bracket screws (D1403/D1503/D1703/D1903/V2203-E2B) or nuts (V2203-T/F2803-E2B).
2. Detach the rocker arm assembly (1).
3. Remove the push rods (2).

(When reassembling)

- When putting the push rods (2) onto the tappets (3), check to see if their ends are properly engaged with the grooves.

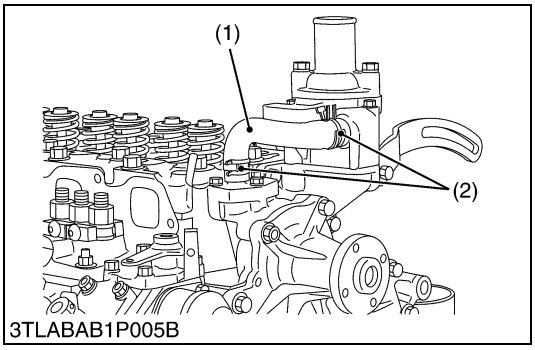
■ **IMPORTANT**

- **After installing the rocker arm, be sure to adjust the valve clearance.**

Tightening torque	Rocker arm bracket screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Rocker arm bracket nut	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Rocker Arm Assembly
(2) Push Rod
(3) Tappet

W1021437



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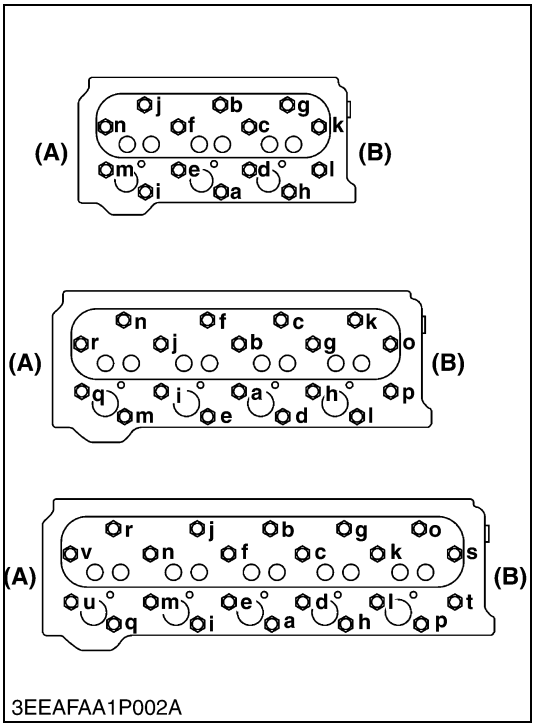

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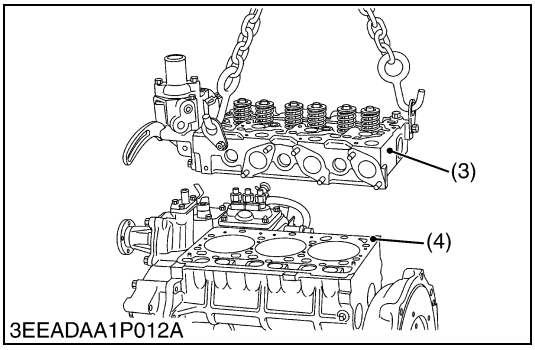

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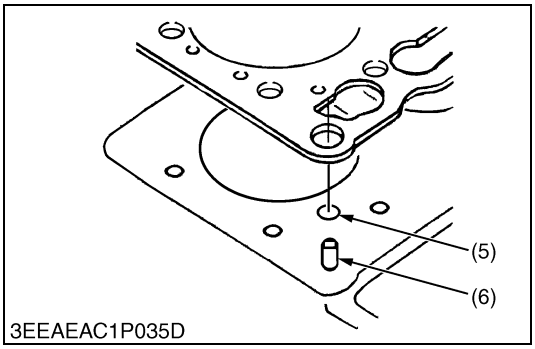

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Cylinder Head

1. Loosen the pipe clamp (2), and remove the water return pipe (1).
2. Remove the cylinder head screw in the order of (**v** or **r** or **n**) to (**a**).
3. Lift up the cylinder head (3) to detach.
4. Remove the cylinder head gasket (4) and O-ring (5).

(When reassembling)

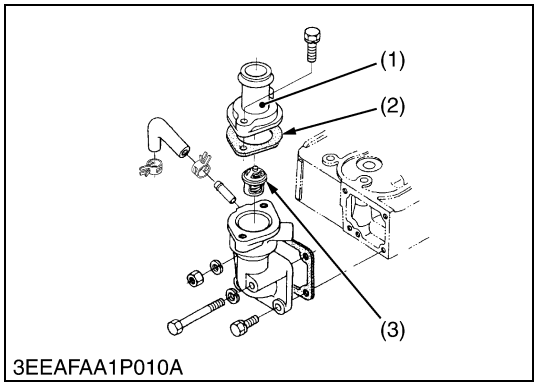
- Replace the cylinder head gasket (4) with a new one.
- Securely fit the O-ring (5) to the pin pipe (6).
- Tighten the cylinder head screws after applying sufficient oil.
- Tighten the cylinder head screws in diagonal sequence starting from the center in the order of (**a**) to (**n** or **r** or **v**).
- Tighten them uniformly, or the head may deform in the long run.
- Retighten the cylinder head screws after running the engine for 30 minutes.

Tightening torque	Cylinder head screw	93.2 to 98.1 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft-lbs

(1) Return Pipe
(2) Pipe Clamp
(3) Cylinder Head
(4) Cylinder Head Gasket
(5) O-ring
(6) Pin Pipe

(v or n or r) to (a): To Loosen
(a) to (n or r or v): To Tighten
(A) Gear Case Side
(B) Flywheel Side

W1021755



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Thermostat Assembly

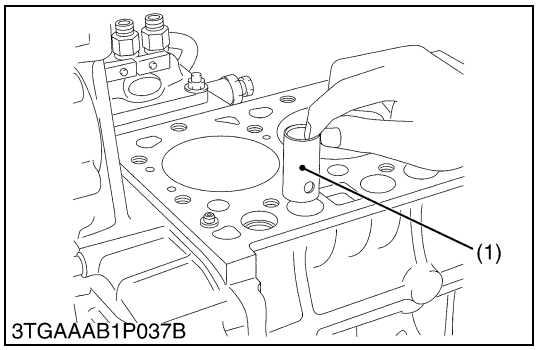
1. Remove the thermostat cover mounting screws, and remove the thermostat cover (1).
2. Remove the thermostat assembly (3).

(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the thermostat cover gasket (2).

(1) Thermostat Cover
(2) Thermostat Cover Gasket
(3) Thermostat Assembly

W10363950



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Tappets

1. Remove the tappets (1) from the crankcase.

(When reassembling)

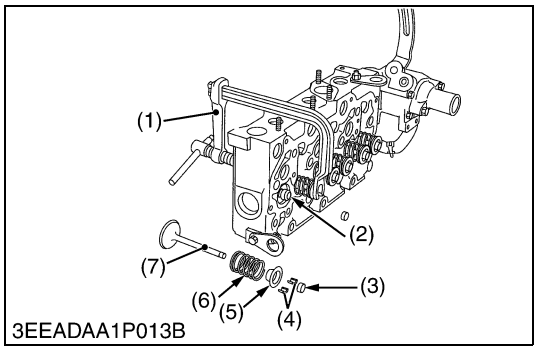
- Visually check the contact between tappets and cams for proper rotation. If defect is found, replace tappets.
- Before installing the tappets, apply engine oil thinly around them.

■ **IMPORTANT**

- **Do not change the combination of tappet and tappet guide.**

(1) Tappet

W1022001



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Valves

1. Remove the valve caps (3).
2. Remove the valve spring collet (4), pushing the valve spring retainer (5) by valve spring replacer (1).
3. Remove the valve spring retainer (5), valve spring (6) and valve stem seal (2).
4. Remove the valve (7).

(When reassembling)

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets (4), lightly tap the stem to assure proper fit with a plastic hammer.

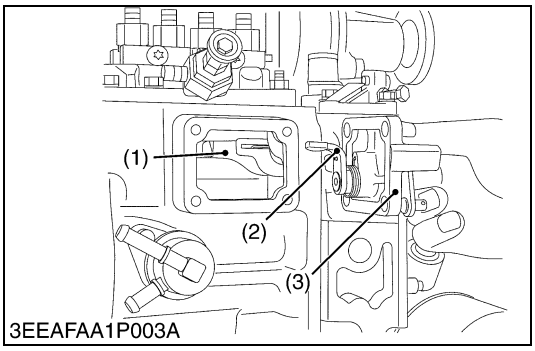
■ **IMPORTANT**

- **Do not change the combination of valve and valve guide.**

(1) Valve Spring Replacer
(2) Valve Stem Seal
(3) Valve Cap
(4) Valve Spring Collet
(5) Valve Spring Retainer
(6) Valve Spring
(7) Valve

W1022102

(4) Gear Case and Timing Gears



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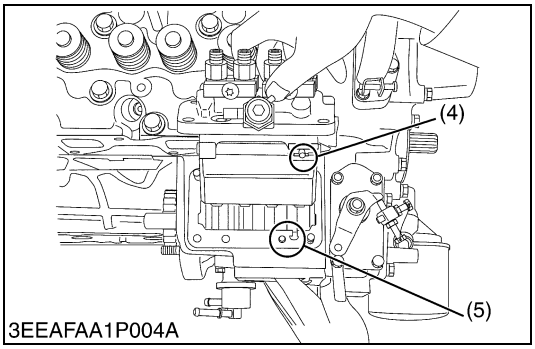

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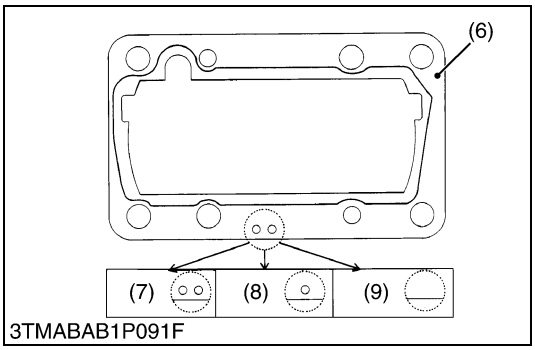

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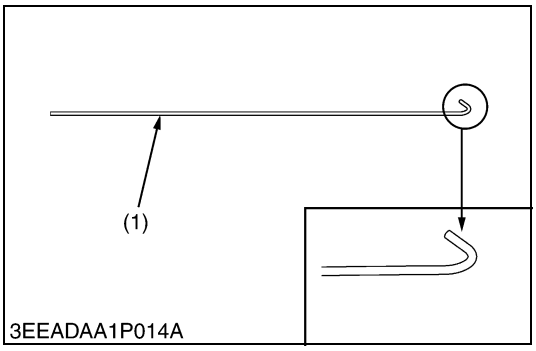

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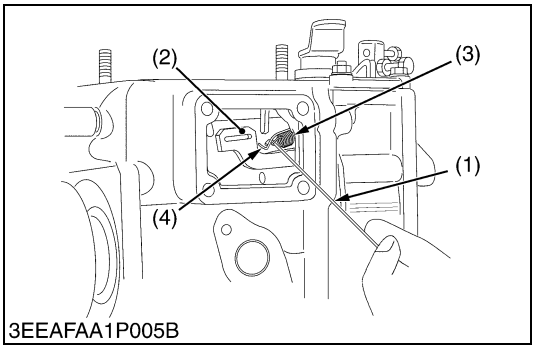

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Injection Pump

1. Remove the injection pump cover (3) with the engine stop lever (2).
2. Remove the injection pump mounting screws and nuts.
3. Align the control rack pin (4) with the groove (5) on the crankcase, then remove the injection pump.
4. Remove the injection pump timing shims (6).
5. In principle, the injection pump should not be disassemble.

(When reassembling)

- Install the injection pump so that its control rack pin (4) engages with the groove (5) of fork lever 1 (1).
- Install the injection pump cover with the arm of engine stop lever (2) at the right of the arm of fork lever 1 (1).
- The sealant is applied to both sides of the shim (soft metal gasket shim). The liquid gasket is not required for assembling.
- Addition or reduction of shims (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.009 rad (0.5 °).
- In disassembling and replacing, be sure to use same number of new shims with the same thickness.
- Refer to figure left to check the thickness of the shims.

(1) Fork Lever 1
(2) Engine Stop Lever
(3) Injection Pump Cover
(4) Control Rack Pin
(5) Groove
(6) Shim
(7) 2-holes : 0.20 mm (0.0079 in.)
(8) 1-hole : 0.25 mm (0.0098 in.)
(9) Without hole : 0.30 mm (0.0118 in.)

W1023637

Governor Spring

■ **NOTE**

- **Specific tool (1) :**
  1.2 mm diameter hard wire with its end hooked, overall length 200 mm (7.87 in.).
  The tip of wire is bent like the hook to hang governor springs.

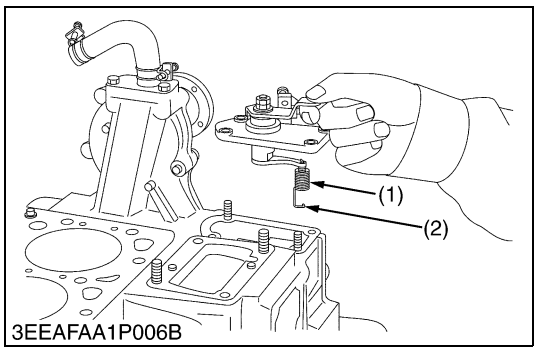
1. Disconnect the governor spring 1 (2) and 2 (3) from the fork lever 2 (4).

(When reassembling)

- Fix the governor spring to the speed control lever, and pull the spring or wire through the window of the injection pump, and spring will be able to be hooked on the governor fork with ease. Bend the end of the governor spring to prevent if from falling off.

(1) Specific Tool
(2) Governor Spring 1
(3) Governor Spring 2
(4) Fork Lever 2

W1024893



Speed Control Plate

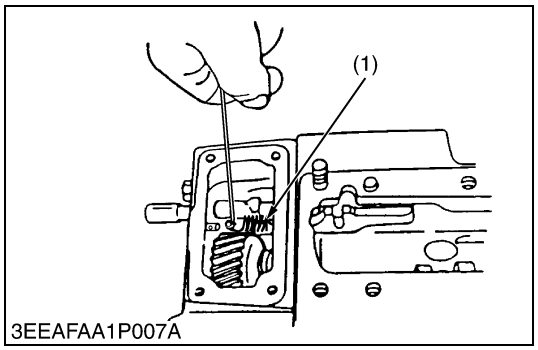
1. Remove the speed control plate and governor spring 1 (2) and 2 (1).

(When reassembling)

- Be careful not to drop the governor spring in the gear case.
- Apply a liquid gasket (Three Bond 1215 or equivalent) to both sides of the speed control plate gasket.

(1) Governor Spring 2 (2) Governor Spring 1

W1025063



Start Spring

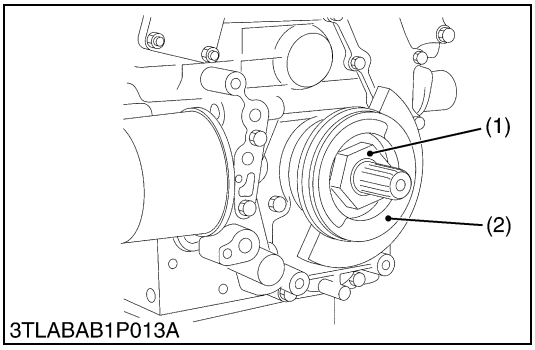
1. Remove the start spring (1) from the gear case.

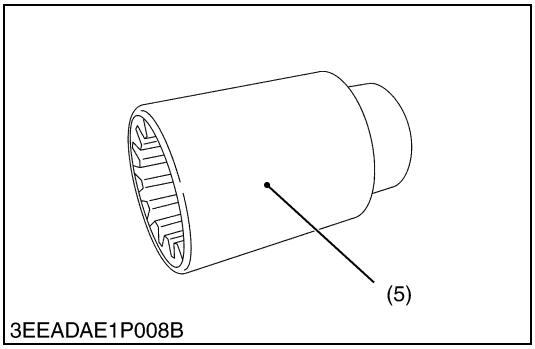
(When reassembling)

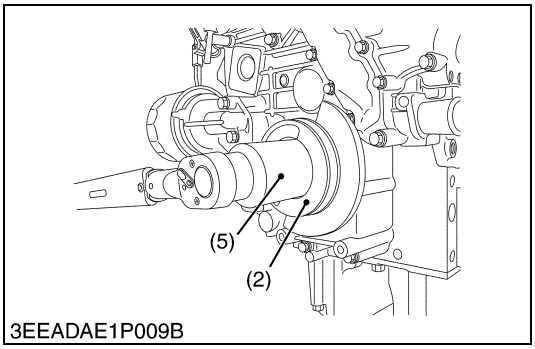
- Be careful not to drop the start spring into the gear case.
- Hook the start spring so that the longer hook is on the fork lever side.

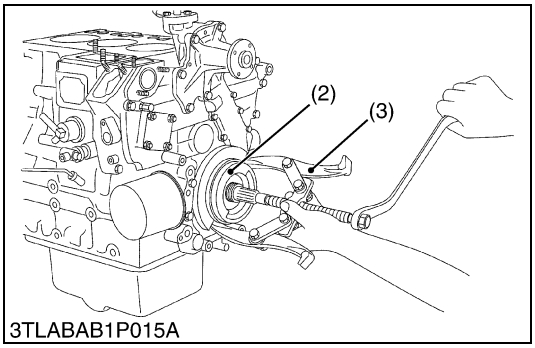
(1) Start Spring

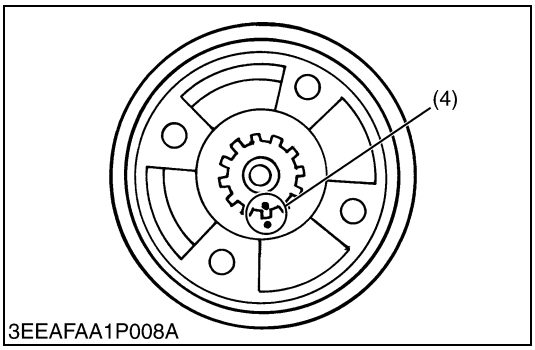
W1025252











Fan Drive Pulley

1. Lock the flywheel not to turn using the flywheel stopper.
2. **[D1403/D1503/D1703/V1903/V2003-T/V2203-E2B]**
   Remove the fan drive pulley mounting nut (1) using 46 mm deep socket wrench (5).
   [F2803-E2B]
   Remove the fan drive pulley screws.
3. Remove the fan drive pulley (2) with gear puller (3).
4. **[D1403/D1503/D1703/V1903/V2003-T/V2203-E2B]**
   Remove the feather key.

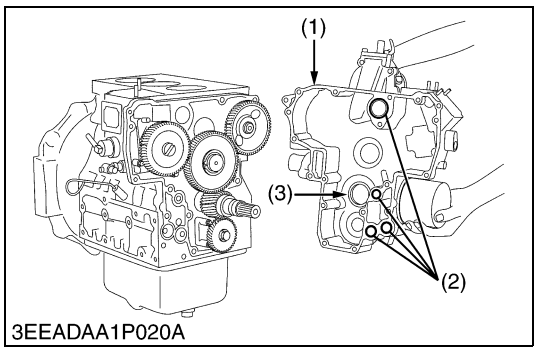
(When reassembling)

- Apply grease to the splines of coupling.
- **[F2803-E2B]**
  Install the pulley to the crankshaft, aligning the marks (4) on them.
- Tighten the fan drive pulley mounting nut or the fan drive pulley screw to the specified torque.

Tightening torque	Fan drive pulley mounting nut	137.3 to 156.9 N·m 14.0 to 16.0 kgf·m 101.3 to 115.7 ft-lbs
	Fan drive pulley screw	313.8 to 333.4 N·m 32.0 to 34.0 kgf·m 231.5 to 245.9 ft-lbs

(1) Nut
(2) Fan Drive Pulley
(3) Gear Puller
(4) Mark
(5) 46 mm Deep Socket Wrench

W1025370



Gear Case

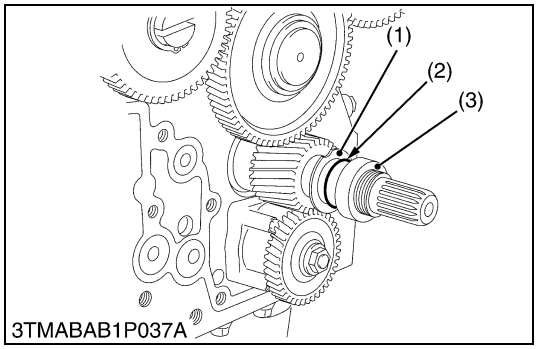
1. Remove the hour meter gear case (if equipped).
2. Remove the gear case (1).
3. Remove the O-rings (2).

(When reassembling)

- Apply liquid gasket (Three Bond 1215 or equivalent) to both side of hour meter gear case gasket.
- Check to see if there are four O-rings (2) inside the gear case (1).
- Apply a thin film of engine oil to the oil seal (3), and install it, noting the lip come off.
- Before installing the gear case gasket, apply a non-drying adhesive.

(1) Gear Case
(2) O-ring
(3) Oil Seal

W1024531



Crankshaft Oil Slinger

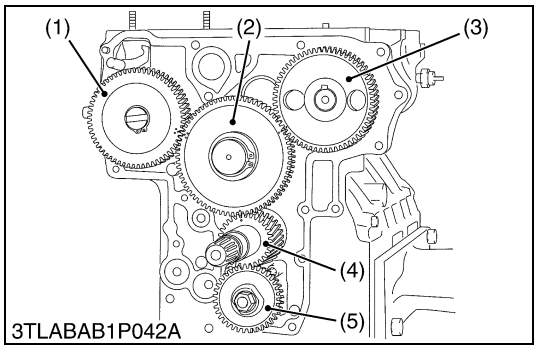
1. Remove the crankshaft collar (3).
2. Remove the O-ring (2).
3. Detach the crankshaft oil slinger (1).

(When reassembling)

- Insert the crankshaft collar (3) after install the gear case to cylinder body.

(1) Crankshaft Oil Slinger
(2) O-ring
(3) Crankshaft Collar

W1024731



Idle Gear

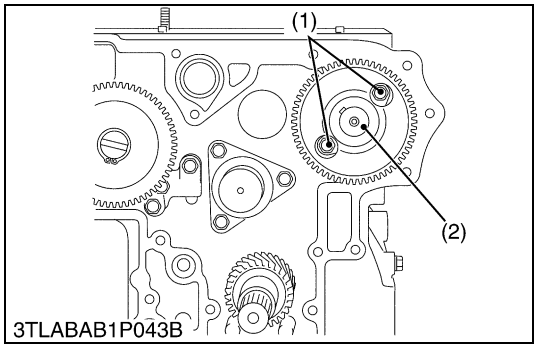
1. Remove the external snap ring.
2. Detach the idle gear collar.
3. Detach the idle gear (2).

(When reassembling)

- Check to see each gear is aligned with its aligning mark
  - Idle gear (2) and crank gear (4)
  - Idle gear (2) and cam gear (3)
  - Idle gear (2) and injection pump gear (1)

(1) Injection Pump Gear
(2) Idle Gear
(3) Cam Gear
(4) Crank Gear
(5) Oil Pump Drive Gear

W1024941



Camshaft

1. Remove the camshaft set screw (1) and draw out the camshaft (2).

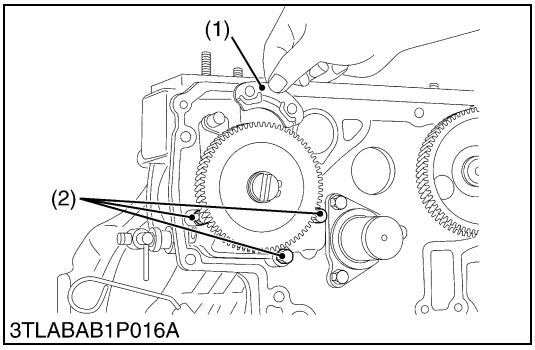
(When reassembling)

- When installing the idle gear, be sure to align the alignment marks on gears.

Tightening torque	Camshaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Camshaft Set Screw
(2) Camshaft

W1025098

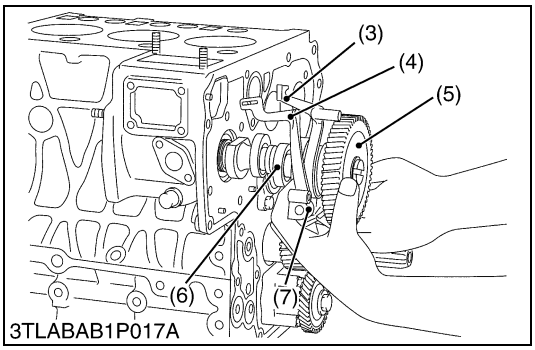


Fuel Camshaft and Fork Lever Assembly

1. Remove the fuel feed pump.
2. Detach the fuel camshaft stopper (1).
3. Remove the three fork lever holder mounting screws (2).
4. Draw out the fuel camshaft assembly (5), (6) and fork lever assembly (3), (4), (7) at the same time.

(When reassembling)

- After installation, check to see that the fork lever 1 (3) and lever 2 (4) are fixed to the fork lever shaft, and that they can turn smoothly in the holder (7).

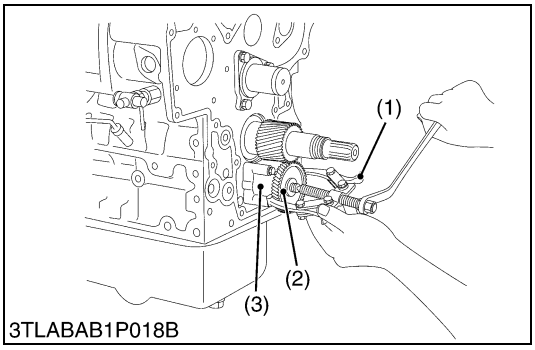


(1) Fuel Camshaft Stopper
(2) Fork Lever Holder Mounting Screw
(3) Fork Lever 1
(4) Fork Lever 2
(5) Injection Pump Gear
(6) Fuel Camshaft
(7) Fork Lever Holder

W1025309

Oil Pump

1. Remove the nut.
2. Draw out the oil pump drive gear (2) with gear puller (1).
3. Remove the four oil pump mounting screws. Detach the oil pump (3).



(1) Gear Puller
(2) Oil Pump Drive Gear
(3) Oil Pump

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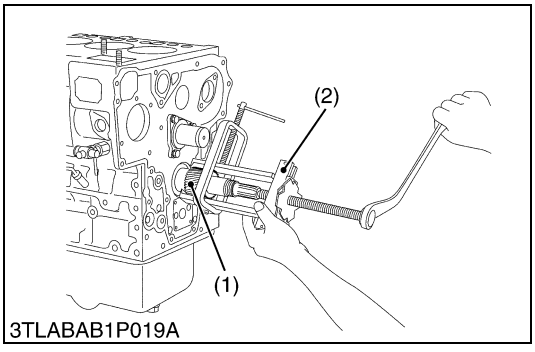
Crank Gear

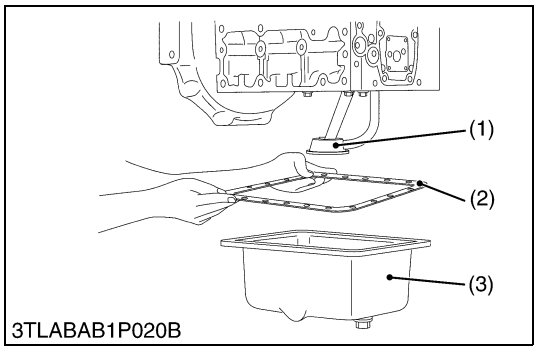
1. Draw out the crank gear (1) with a puller (2).
2. Remove the feather key.



(1) Crank Gear
(2) Gear Puller

W1025476

(5) Piston and Connecting Rod



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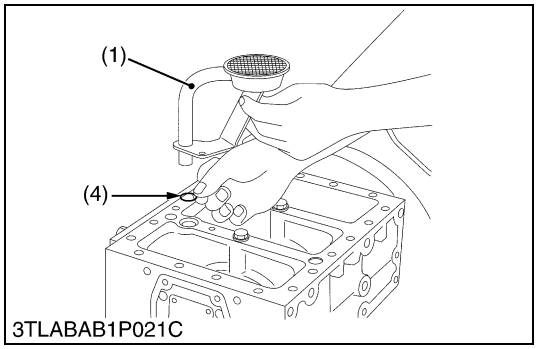

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Oil Pan and Oil Strainer

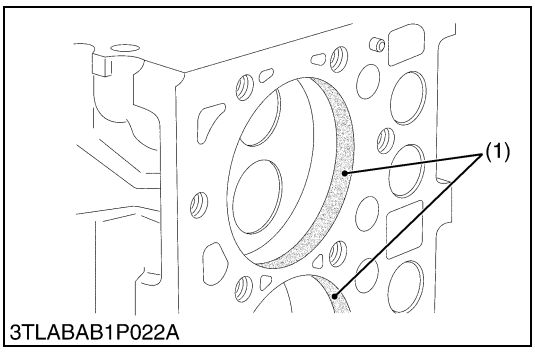
1. Remove the oil pan mounting screws.
2. Remove the oil pan (3) by lightly tapping the rim of the pan with a wooden hammer.
3. Remove the oil pan gasket (2).
4. Remove the oil strainer (1) and O-ring (4).

(When reassembling)

- After cleaning the oil strainer (1), check to see that the filter mesh in clean, and install it.
- Visually check the O-ring (4), apply engine oil, and install it.
- Securely fit the O-ring (4) to the oil strainer (1).
- Apply a liquid gasket (Three Bond 1215 or equivalent) to the oil pan side of the oil pan gasket (2).
- To avoid uneven tightening, tighten oil pan mounting screws in diagonal order from the center.

(1) Oil Strainer
(2) Oil Pan Gasket
(3) Oil Pan
(4) O-ring

W1025687



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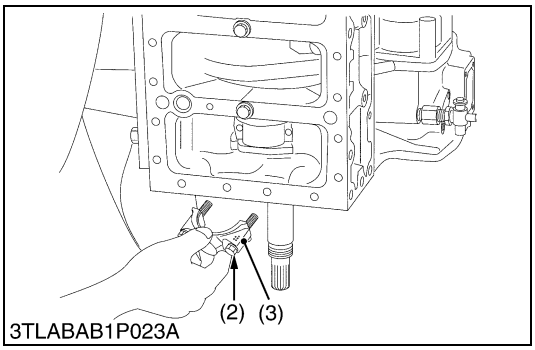

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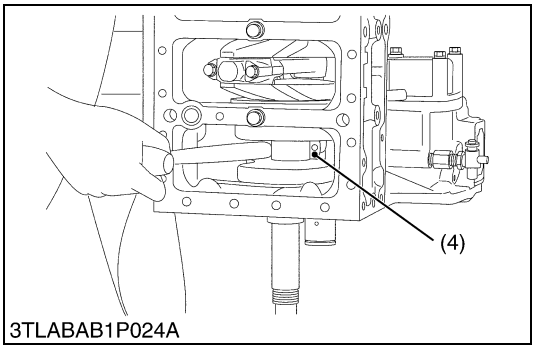

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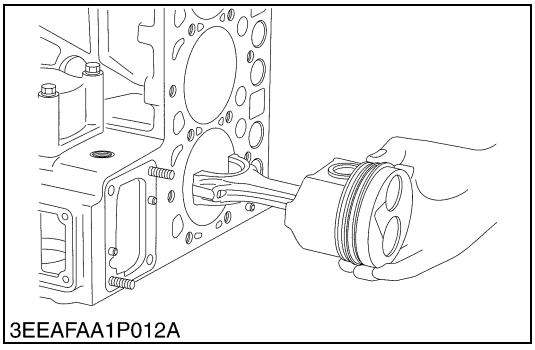
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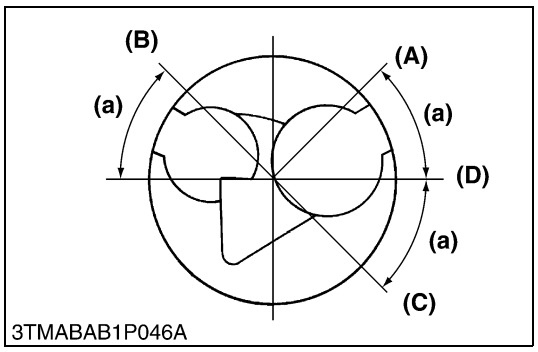
Pistons (To be continued)

1. Completely clean carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and bring the piston to top dead center.
4. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
5. Draw out the other piston in the same method as above.

(1) Carbon
(2) Connecting Rod Screw
(3) Connecting Rod Cap
(4) Connecting Rod

W1026909



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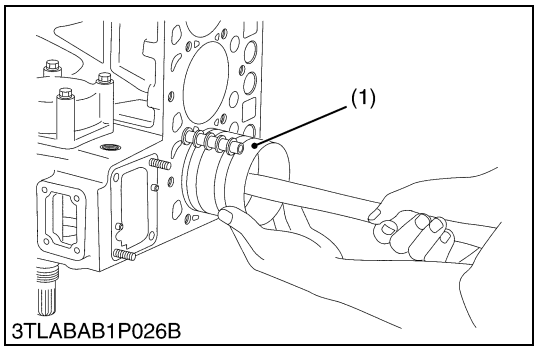

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Pistons (Continued)

(When reassembling)

- Before inserting piston into the cylinder, apply enough engine oil to the piston.
- When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

■ **IMPORTANT**

- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 piston.**
- **Place the piston rings with their gaps at 0.79 rad (45 °) from the piston pin's direction as shown in the figure.**
- **Carefully insert the pistons using a piston ring compressor (1).**

Tightening torque	Connecting rod screw	44.1 to 49.0 N·m 4.5 to 5.0 kgf·m 32.5 to 36.2 ft-lbs

(1) Piston Ring Compressor

(A) Top Ring Gap

(B) Second Ring Gap

(C) Oil Ring Gap

(D) Piston Pin Hole

(a) 0.79 rad (45 °)

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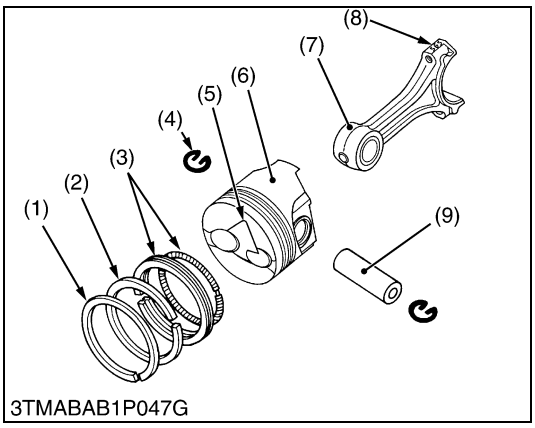

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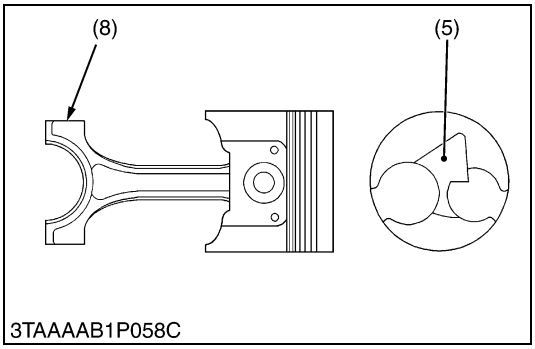

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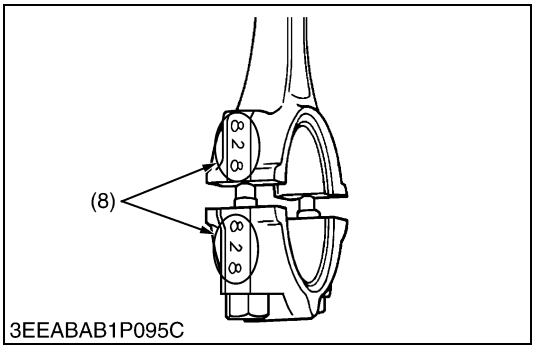

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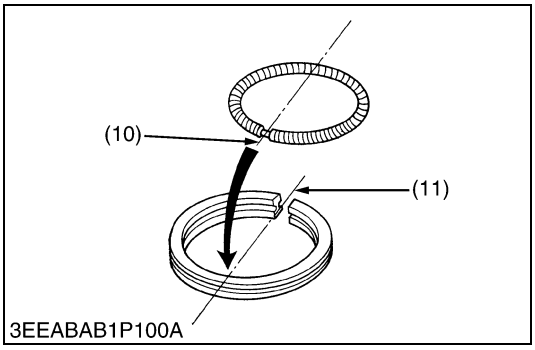

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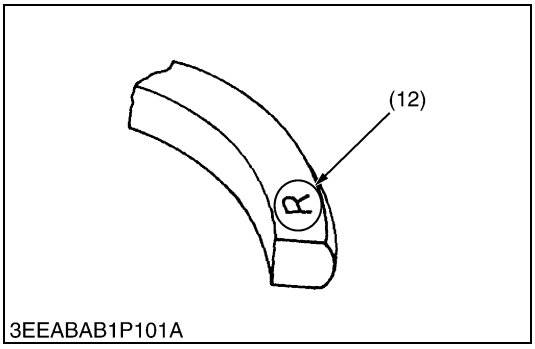

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Piston Ring and Connecting Rod

1. Remove the piston rings (1), (2), (3) using a piston ring tool.
2. Remove the piston pin (9), and separate the connecting rod (7) from the piston (6).

(When reassembling)

- When installing the rings, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston (6).
- When installing the oil ring (3) onto the piston (6), place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin (9).
- When installing the connecting rod (7) to the piston (6), immerse the piston (6) in 80 °C (176 °F) oil for 10 to 15 minutes and insert the piston pin (9) to the piston (6).
- When installing the connecting rod (7) to the piston (6), align the mark (8) on the connecting rod (7) to the fan-shaped concave (5).

■ **NOTE**

- **Mark the same number on the connecting rod (7) and the piston (6) so as not to change the combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Ring
(5) Fan-Shaped Concave
(6) Piston
(7) Connecting Rod
(8) Mark
(9) Piston Pin
(10) Expander Joint
(11) Oil Ring Gap
(12) Manufacturer's Mark

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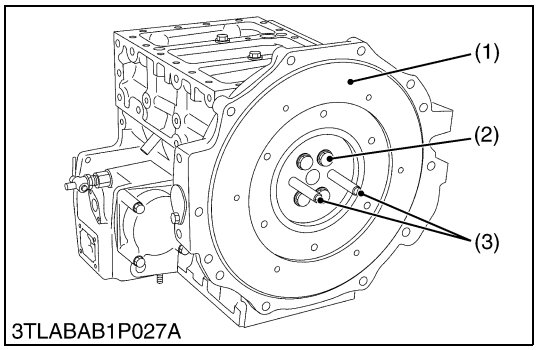
(6) Flywheel and Crankshaft



Flywheel

1. Fit the stopper to the flywheel (1).
2. At first, remove two pieces of the flywheel screws (2).
3. Insert two pieces of the flywheel guide screws (3) in the holes.
4. Remove the all flywheel screws (2).
5. Remove the flywheel (1) slowly along the flywheel guide screws (3).

(When reassembling)

- Insert two pieces of the flywheel guide screws (3).
- Check to see that there are no metal particles left on the flywheel mounting surfaces.
- Apply engine oil to the threads and the undercut surface of the flywheel bolt and fit the bolt.

Tightening torque	Flywheel screw	98.1 to 107.9 N·m 10.0 to 11.0 kgf·m 72.3 to 79.6 ft-lbs

(1) Flywheel
(2) Flywheel Screw
(3) Flywheel Guide Screw

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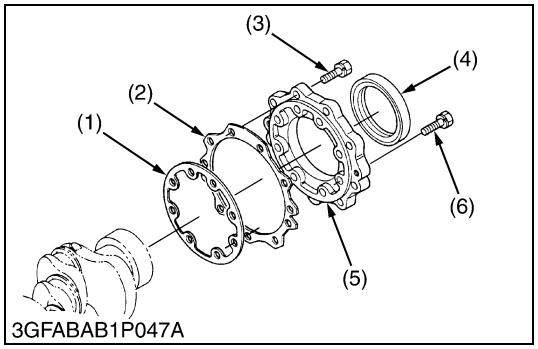


Bearing Case Cover

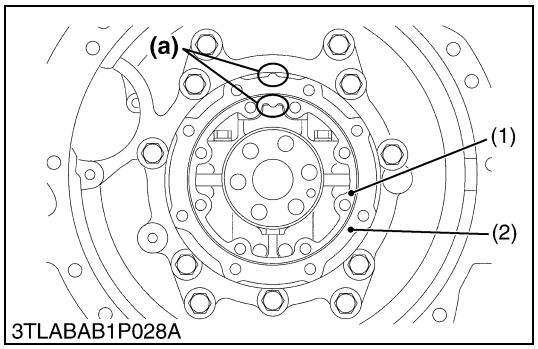
1. Remove the bearing case cover mounting screws. First, remove inside screws (6) and then outside screws (3).
2. Screw two removed screws into the screw hole of bearing case cover (5) to remove it.

■ **IMPORTANT**

- **The length of inside screws (6) and outside screws (3) are different. Do not take a mistake using inside screws and outside screws.**

(When reassembling)

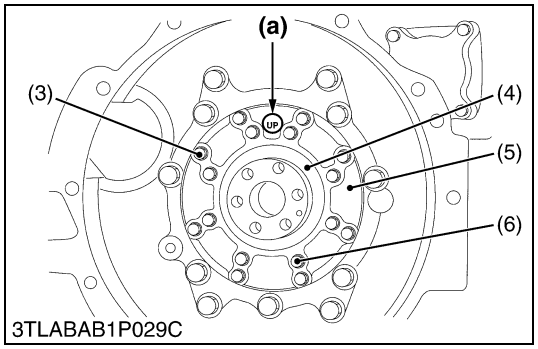
- Fit the bearing case gasket (1) and the bearing case cover gasket (2) with correct directions.
- Install the bearing case cover (5) to position the casting mark **"UP"** on it upward.
- Apply engine oil to the oil seal lip and take care that it is not rolled when installing.
- Tighten the bearing case cover mounting screws with even force on the diagonal line.

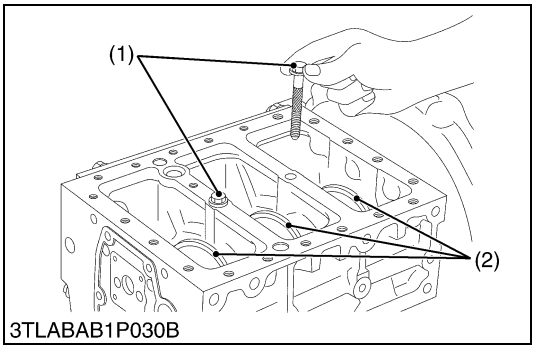


Tightening torque	Bearing case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Bearing Case Gasket
(2) Bearing Case Cover Gasket
(3) Bearing Case Cover Mounting Screw
(4) Oil Seal
(5) Bearing Case Cover
(6) Bearing Case Cover Mounting Screw
(a) Upside

W10292140





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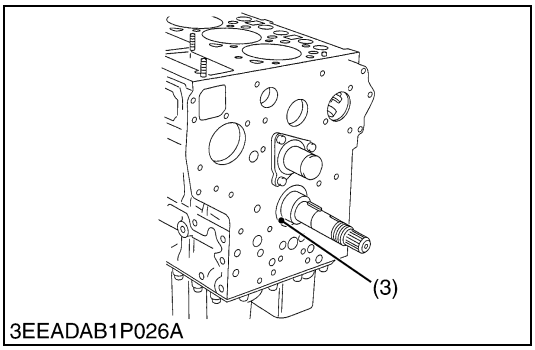

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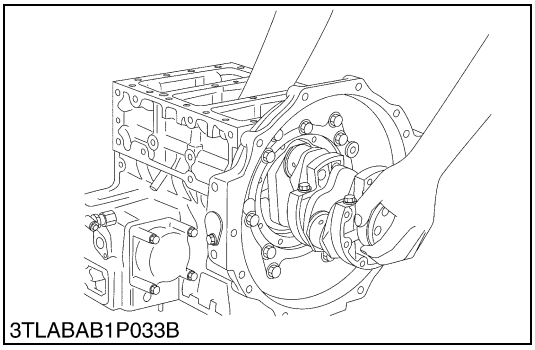
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Crankshaft

■ **NOTE**

- **Before disassembling, check the side clearance of crankshaft. Also check it during reassembling.**

1. Remove the main bearing case screw 2 (1).
2. Pull out the crankshaft assembly, taking care not to damage the crankshaft bearing 1 (3).

(When reassembling)

■ **IMPORTANT**

- **Install the crankshaft sub assembly, aligning the screw hole of main bearing case 2 (2) with the screw hole of cylinder block.**
- **When tightening the main bearing case screw 2 (1), apply oil to the screw and screw by hand before tightening the specific torque.**
  If not smooth to screw by hand, align the screw holes between the cylinder block and the main bearing case.

Tightening torque	Main bearing case screw 2	68.6 to 73.5 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 ft-lbs

(1) Main Bearing Case Screw 2
(2) Main Bearing Case 2
(3) Crankshaft Bearing 1

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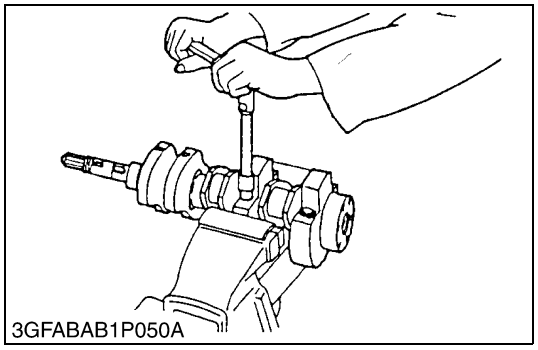
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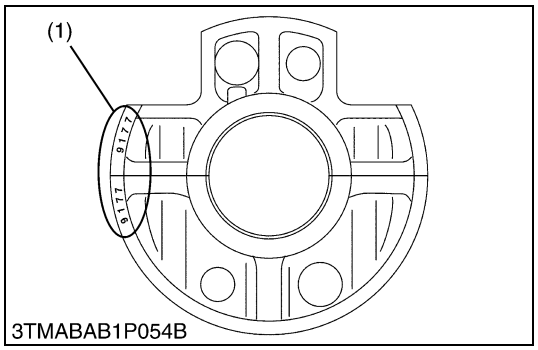

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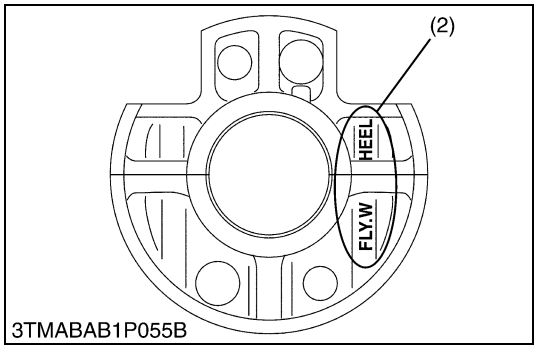

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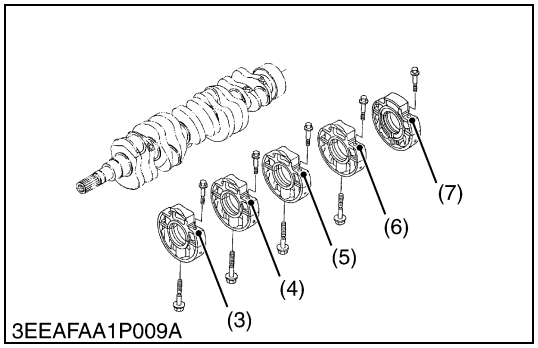

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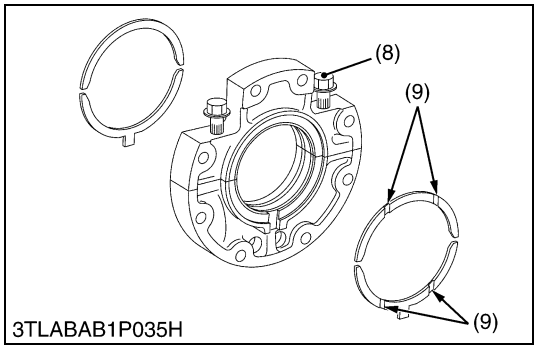

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Main Bearing Case Assembly

1. Remove the two main bearing case screws 1 (8), and remove the main bearing case assembly being careful with thrust bearing and crankshaft bearing.
2. Remove the main bearing case 1, 2 as above.

(When reassembling)

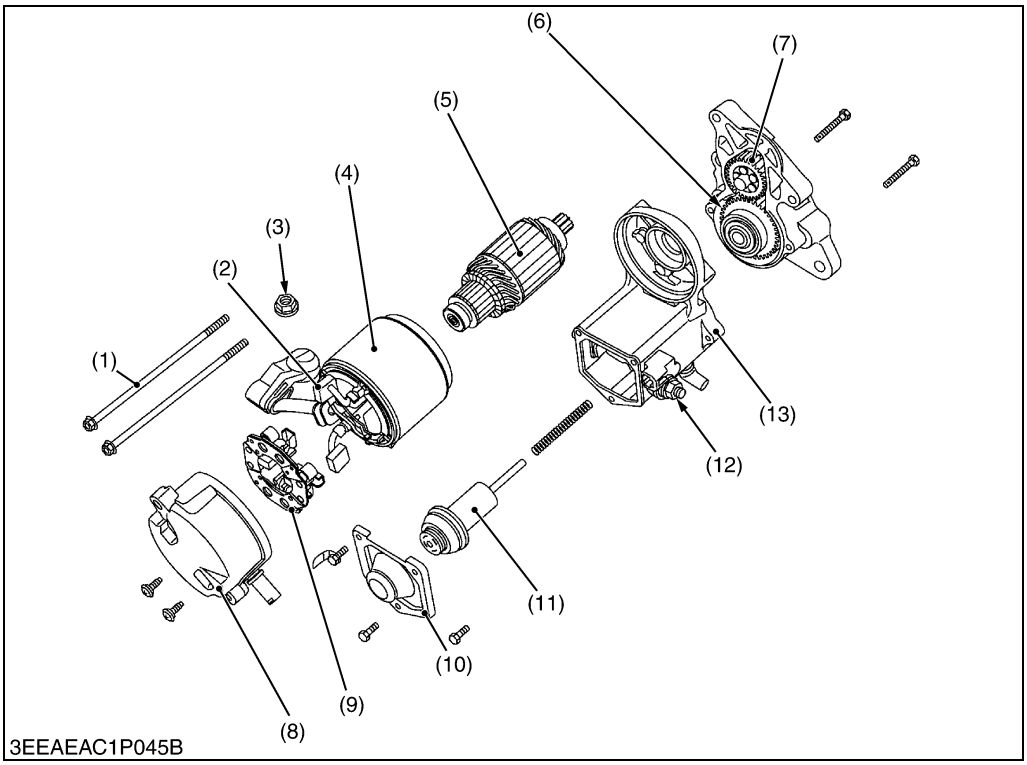
- Clean the oil passage in the main bearing case.
- Apply clean engine oil on the bearings.
- Install the main bearing case assemblies in the original positions. Since diameters of main bearing cases vary, install them in order of makings (A, B for 3 cylinders, A, B, C for 4 cylinders and A, B, C, D for 5 cylinders) from the gear case side.
- Match the alignment numbers (1) and mark (2) on the main bearing case.
- When installing the main bearing case 1 and 2, face the mark **"FLYWHEEL"** to the flywheel.
- Install the thrust bearing with its oil groove (9) facing outward.
- Confirm that the main bearing case moves smoothly after tightening the main bearing case screw 1 (8) to the specified torque.

Tightening torque	Main bearing case screw 1	46.1 to 51.0 N·m 4.7 to 5.2 kgf·m 34.0 to 37.6 ft-lbs

(1) Alignment Number
(2) Alignment Mark
(3) A
(4) B
(5) C
(6) D
(7) No Mark
(8) Main Bearing Case Screw 1
(9) Oil Groove

W1027366

(7) Starter



(1) Through Bolt
(2) Brush
(3) **C** Terminal Nut
(4) Yoke
(5) Armature
(6) Overrunning Clutch
(7) Idle Gear
(8) End Frame
(9) Brush Holder
(10) Magnet Switch Cover
(11) Plunger
(12) **B** Terminal Nut
(13) Housing

W1222714

1. Unscrew the **C** terminal nut (3), and disconnect the connecting lead.
2. Remove the two through bolts (1).
3. Detach the motor.
4. Remove the end frame (8).
5. Remove the brush from the brush holder while holding the spring up.
6. Remove the brush holder (9).
7. Draw out the armature (5) from the yoke (4).
8. Remove the housing (13).
9. Remove the idle gear (7) and the overrunning clutch (6).
10. Remove the magnet switch cover (10).
11. Remove the plunger (11).

■ **NOTE**

- **Do not damage to the brush and commutator.**

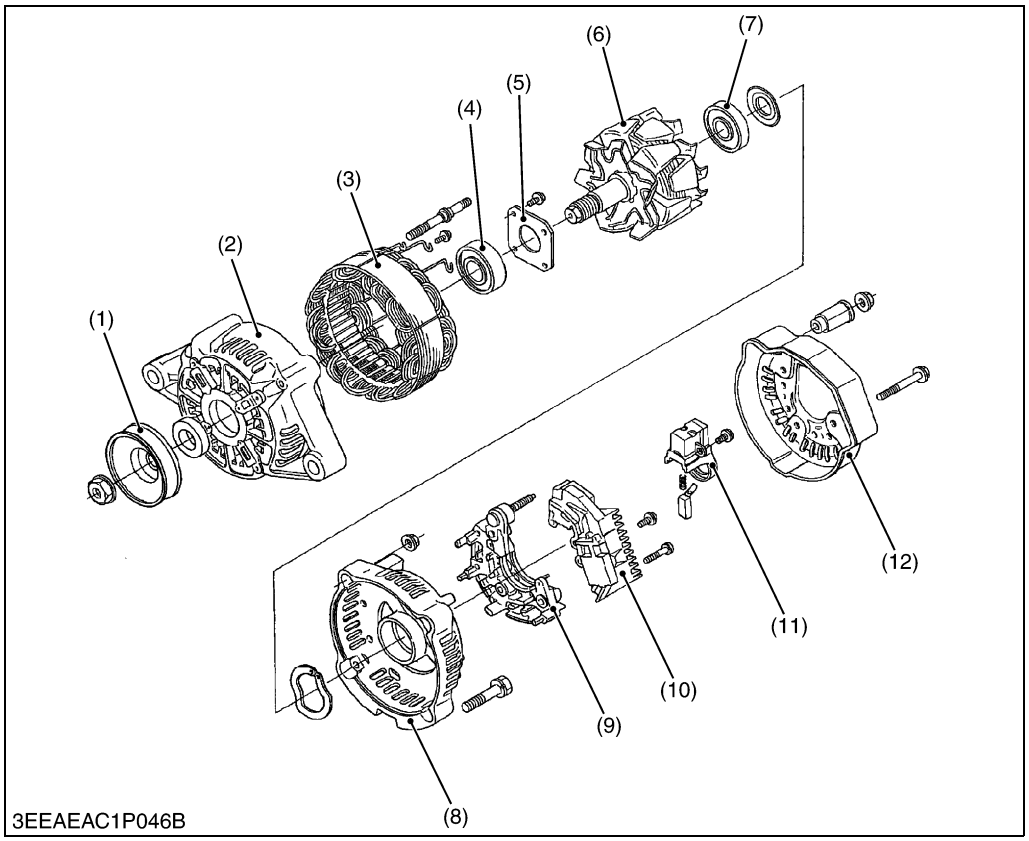
(When reassembling)

- Apply grease (DENSO No. 50 or equivalent) to the idle gear and overrunning clutch portions.

Tightening torque	**B** terminal nut	5.9 to 11.8 N·m 0.6 to 1.2 kgf·m 4.3 to 8.7 ft-lbs

W1012736

(8) Alternator



(1) Pulley
(2) Drive End Frame
(3) Stator
(4) Bearing
(5) Retainer Plate
(6) Rotor
(7) Bearing
(8) Rear End Frame
(9) Rectifier
(10) IC Regulator
(11) Brush Holder
(12) Rear End Cover

W1224079

1. Remove the pulley (1).
2. Remove the rear end cover (12).
3. Remove the brush holder (11).
4. Remove the IC regulator (10).
5. Remove the four screws holding the stator lead wires.
6. Remove the rectifier (9).
7. Remove the rear end frame (8).
8. Press out the rotor (6) from drive end frame (2).
9. Remove the retainer plate (5).
10. Press out the bearing (4) from drive end frame (2) with a press and jig.
11. Lightly secure the rotor with a vise to prevent damage, and remove the bearing (7) with a puller.

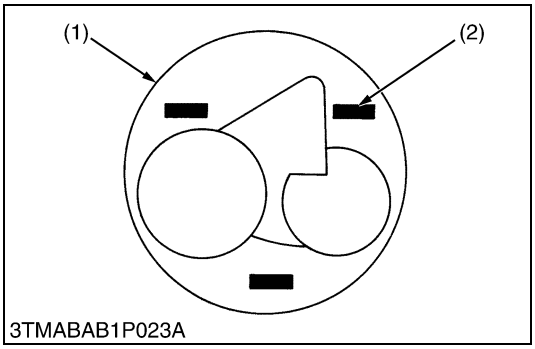
(When reassembling)

Tightening torque	Pulley nut	58.3 to 78.9 N·m 5.95 to 8.05 kgf·m 43.0 to 58.2 ft-lbs

W1224556

[3] SERVICING

(1) Cylinder Head and Valves



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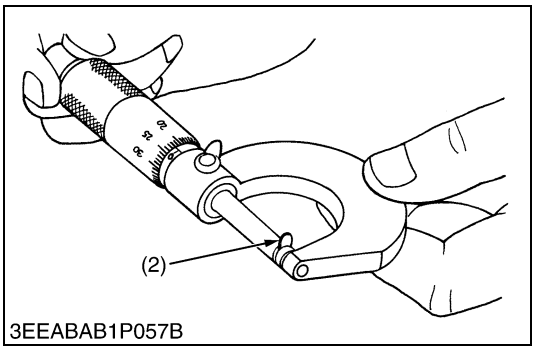

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Top Clearance

1. Remove the cylinder head.
2. Move the piston up and stick a strip of fuse on the piston head at three position with grease.
3. Lower the piston and install the cylinder head. (Use a new cylinder head gasket and tighten with a specified tightening torque.)
4. Turn the flywheel until the piston exceeds top dead center.
5. Remove the cylinder head and measure the thickness of the fuses.
6. If the measurement is not within the factory specifications, check the oil clearances between the crankpin and bearing and between the piston pin and bushing.

■ **NOTE**

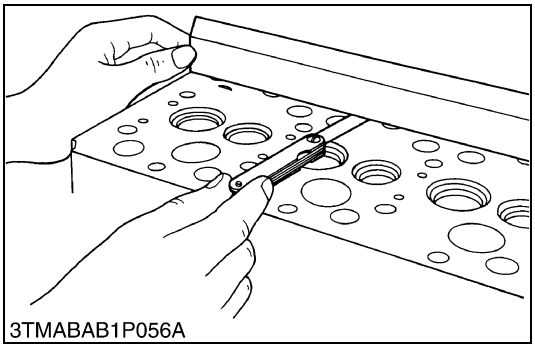
- **After checking the top clearance, be sure to assemble the cylinder head with a new cylinder head gasket.**

Top clearance	Factory spec.	0.55 to 0.70 mm 0.0217 to 0.0276 in.

Tightening torque	Cylinder head screw	93.2 to 98.1 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft-lbs

(1) Piston (2) Fuse

W1020190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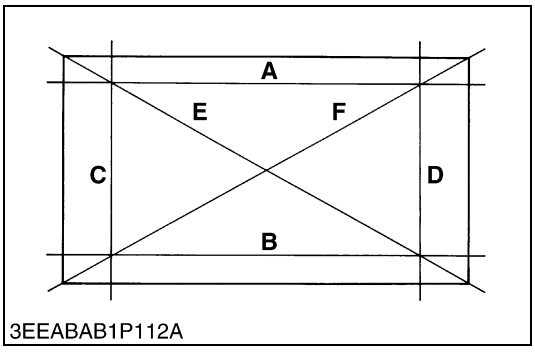
Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides (**A**), (**B**), (**C**) and (**D**) and two diagonal (**E**) and (**F**) as shown in the figure.
3. Measure the clearance with a feeler gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ **IMPORTANT**

- **Do not place the straightedge on the combustion chamber.**
- **Be sure to check the valve recessing after correcting.**



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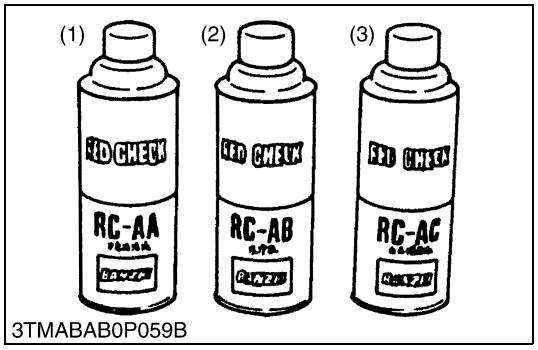
Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.

W1027737



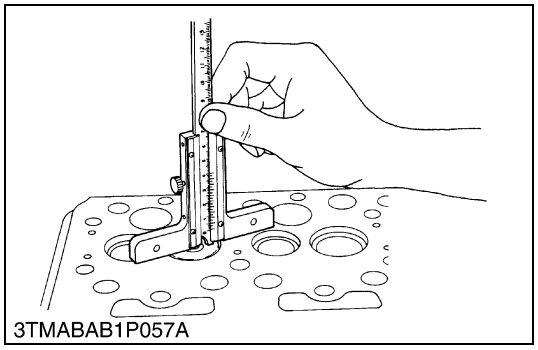
3TMABAB0P059B

Cylinder Head Flaw

1. Prepare an air spray red check.
2. Clean the surface of the cylinder head with the detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the read permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with the white developer (3).
6. If flawed, it can be identified as red marks.

(1) Red Permeative Liquid
(2) Detergent
(3) White Developer

W1076542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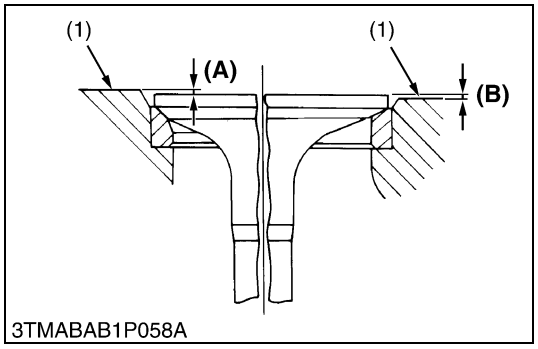
Valve Recessing

1. Clean the cylinder head surface, valve face and valve seat.
2. Insert the valve into the valve guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit, replace the valve.
5. If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

Valve recessing	Factory spec.	0.05 (protrusion) to 0.15 (recessing) mm 0.0020 (protrusion) to 0.0059 (recessing) in.
	Allowable limit	0.40 (recessing) mm 0.0157 (recessing) in.



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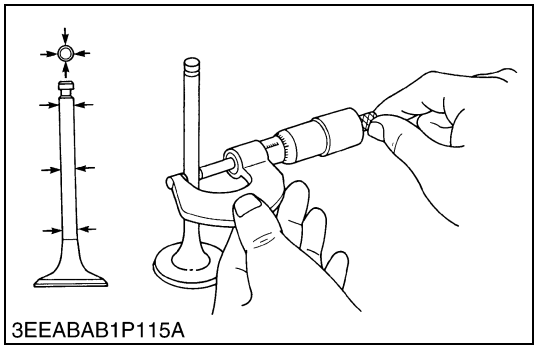
(1) Cylinder Head Surface
(A) Recessing
(B) Protrusion

W10768800

Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valves. If it still exceeds the allowable limit, replace the valve guide.

Clearance between valve stem and valve guide	Factory spec.	0.040 to 0.070 mm 0.00157 to 0.00276 in.
	Allowable limit	0.10 mm 0.0039 in.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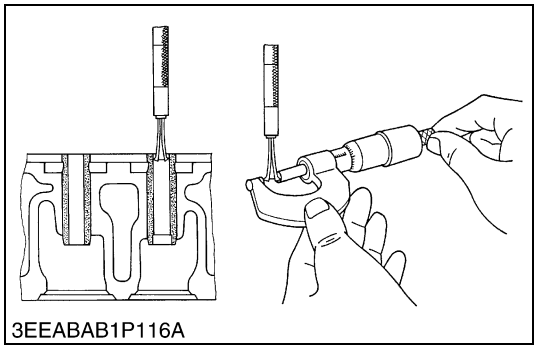
Valve stem O.D.	Factory spec.	7.960 to 7.975 mm 0.31339 to 0.31398 in.
Valve guide I.D.	Factory spec.	8.015 to 8.030 mm 0.31555 to 0.31614 in.

W10774950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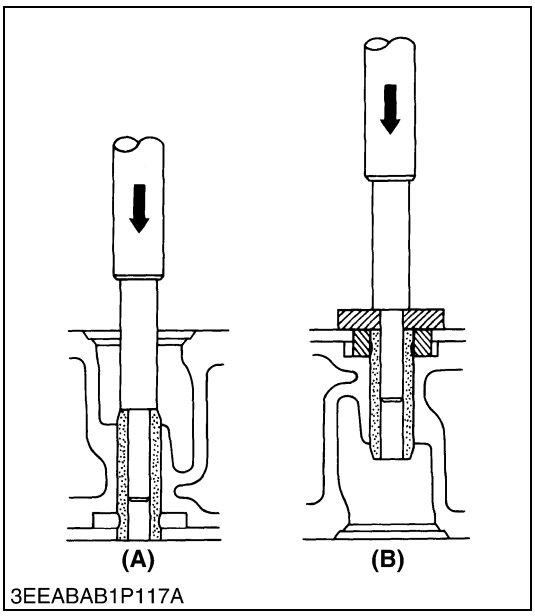

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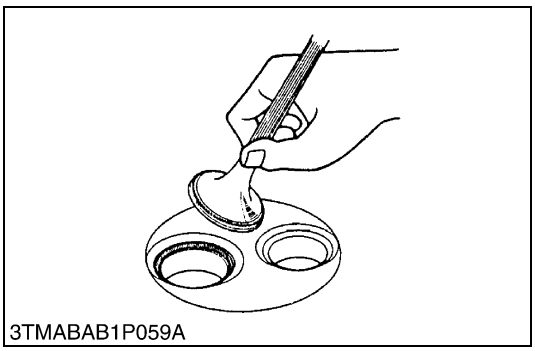
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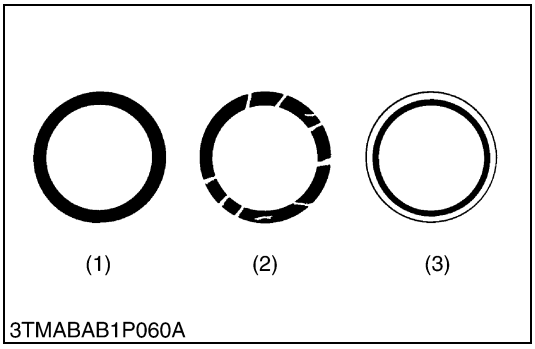

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Replacing Valve Guide

(When removing)

1. Press out the used valve guide using a valve guide replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

1. Clean a new valve guide and valve guide bore, and apply engine oil to them.
2. Press in a new valve guide using a valve guide replacing tool.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

Valve guide I.D. (Intake and exhaust)	Factory spec.	8.015 to 8.030 mm 0.31555 to 0.31614 in.

■ **IMPORTANT**

- **Do not hit the valve guide with a hammer during replacement.**

(A) When Removing **(B) When Installing**

W10278890

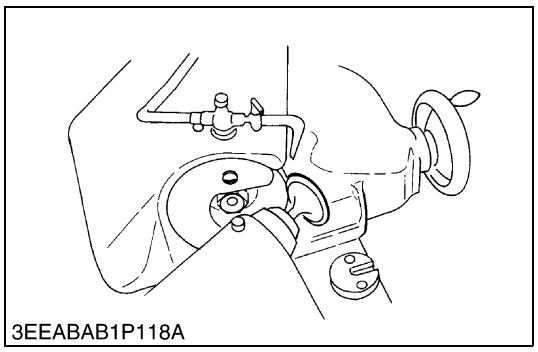
Valve Seating

1. Coat the valve face lightly with prussian blue and put the valve on its seat to check the contact.
2. If the valve does not seat all the way around the valve seat or the valve contact is less than 70 %, correct the valve seating as follows.
3. If the valve contact does not comply with the reference value, replace the valve or correct the contact of valve seating.

Valve seat width	Factory spec.	2.12 mm 0.0835 in.

(1) Correct
(2) Incorrect
(3) Incorrect

W10282190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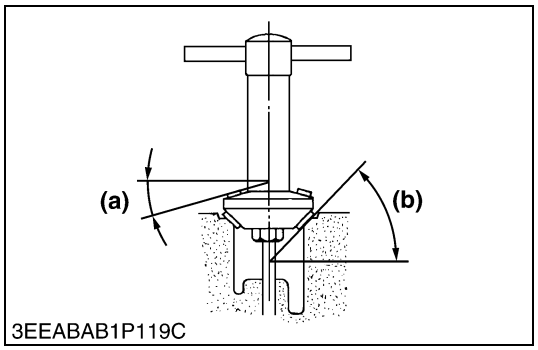

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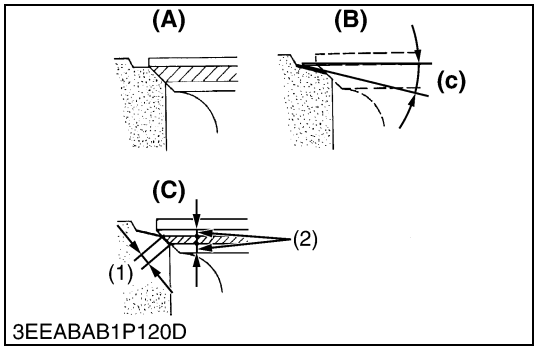

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Correcting Valve and Valve Seat

■ **NOTE**
- **Before correcting the valve and seat, check the valve stem and the I.D. of valve guide section, and repair them if necessary.**
- **After correcting the valve seat, be sure to check the valve recessing.**

1) Correcting Valve

1. Correct the valve with a valve refacer.

Valve face angle	Factory spec.	IN.	1.047 rad 60 °
		EX.	0.785 rad 45 °

2) Correcting Valve Seat

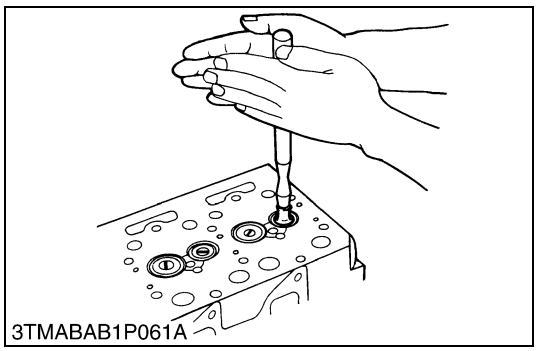
1. Slightly correct the seat surface with a 1.047 rad (60 °) (intake valve) or 0.785 rad (45 °) (exhaust valve) valve seat cutter.
2. Resurface the seat surface with a 0.523 rad (30 °) valve seat cutter to intake valve seat and with a 0.262 rad (15 °) valve seat cutter to exhaust valve seat so that the width is close to specified valve seat width (2.12 mm, 0.0835 in.).
3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compound between the valve face and valve seat, and fit them with valve lapping tool.
4. Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

Valve seat angle	Factory spec.	IN.	1.047 rad 60 °
		EX.	0.785 rad 45 °

(1) Valve Seat Width
(2) Identical Dimensions

(A) Check Contact
(B) Correct Seat Width
(C) Check Contact
(a) 0.262 rad (15 °) or 0.523 rad (30 °)
(b) 0.785 rad (45 °) or 1.047 rad (60 °)
(c) 0.523 rad (30 °) or 0.262 rad (15 °)

W10283500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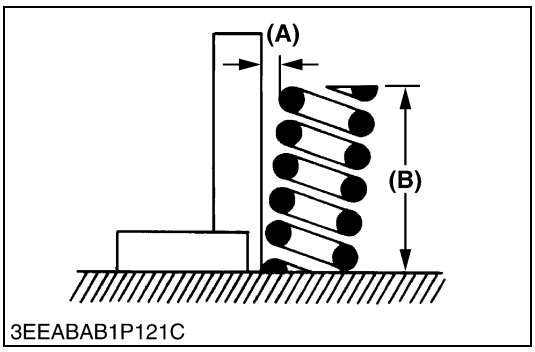
Valve Lapping

1. Apply compound evenly to the valve lapping surface.
2. Insert the valve into the valve guide. Lap the valve onto its seat with a valve flapper or screwdriver.
3. After lapping the valve, wash the compound away and apply oil, then repeat valve lapping with oil.
4. Apply prussian blue to the contact surface to check the seated rate. If it is less than 70 %, repeat valve lapping again.

■ **IMPORTANT**
- **When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.**

W10288140



3EEABAB1P121C

Free Length and Tilt of Valve Spring

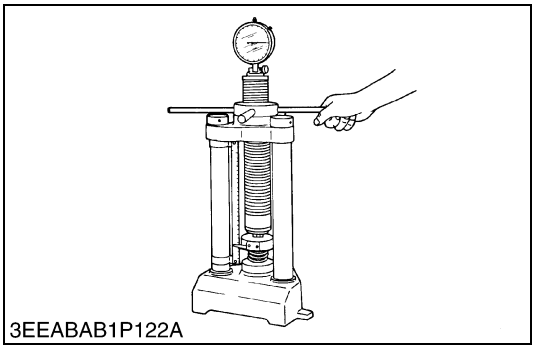
1. Measure the free length **(B)** of valve spring with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the valve spring on a surface plate, place a square on the side of the valve spring.
3. Check to see if the entire side is in contact with the square. Rotate the valve spring and measure the maximum tilt **(A)**. If the measurement exceeds the allowable limit, replace it.
4. Check the entire surface of the valve spring for scratches. If there is any defect, replace it.

Tilt **(A)**	Allowable limit	1.0 mm 0.039 in.

Free length **(B)**	Factory spec.	41.7 to 42.2 mm 1.6417 to 1.6614 in.
	Allowable limit	41.2 mm 1.6220 in.

(A) Tilt **(B) Free Length**

W10289350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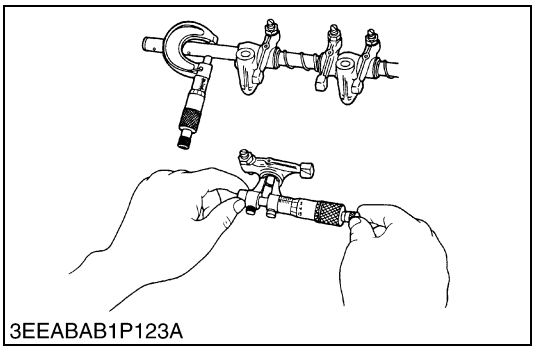
Valve Spring Setting Load

1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load / Setting length	Factory spec.	117.6 N / 35.0 mm 12.0 kgf / 35.0 mm 26.4 lbs / 1.3780 in.
	Allowable limit	100.0 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbs / 1.3780 in.

W10784360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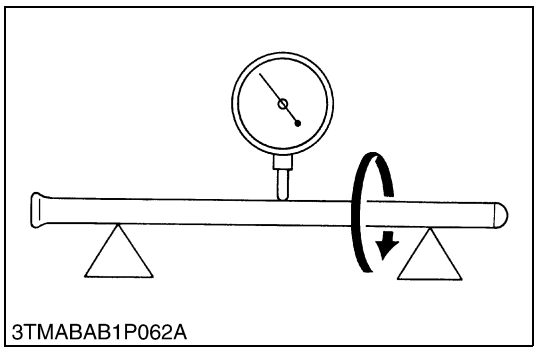
Oil Clearance between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm shaft O.D. with an outside micrometer.
2. Measure the rocker arm I.D. with an inside micrometer, and then calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Oil clearance between rocker arm and rocker arm shaft	Factory spec.	0.016 to 0.045 mm 0.00063 to 0.00177 in.
	Allowable limit	0.10 mm 0.0039 in.

Rocker arm shaft O.D.	Factory spec.	13.973 to 13.984 mm 0.55012 to 0.55055 in.
Rocker arm I.D.	Factory spec.	14.000 to 14.018 mm 0.55118 to 0.55189 in.

W1029150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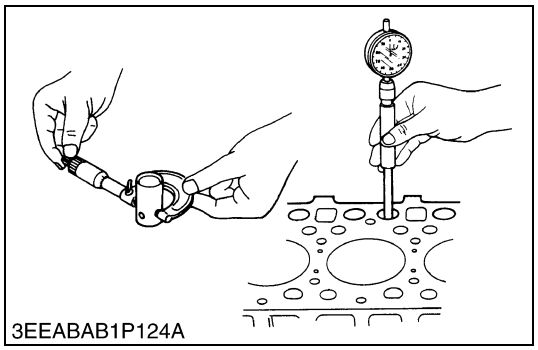
Push Rod Alignment

1. Place the push rod on V blocks.
2. Measure the push rod alignment.
3. If the measurement exceeds the allowable limit, replace the push rod.

Push rod alignment	Allowable limit	0.25 mm 0.0098 in.

W10292900


3EEABAB1P124A

Oil Clearance between Tappet and Tappet Guide Bore

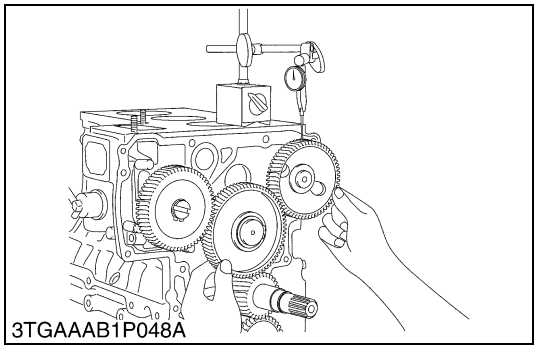
1. Measure the tappet O.D. with an outside micrometer.
2. Measure the I.D. of the tappet guide bore with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit or the tappet is damaged, replace the tappet.

Oil Clearance between tappet and tappet guide bore	Factory spec.	0.020 to 0.062 mm 0.00079 to 0.00244 in.
	Allowable limit	0.07 mm 0.0028 in.

Tappet O.D.	Factory spec.	23.959 to 23.980 mm 0.94327 to 0.94410 in.
Tappet guide bore I.D.	Factory spec.	24.000 to 24.021 mm 0.94488 to 0.94571 in.

W1029366

(2) Timing Gears


3TGAAAB1P048A

Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and the gear.
4. If the oil clearance is proper, replace the gear.

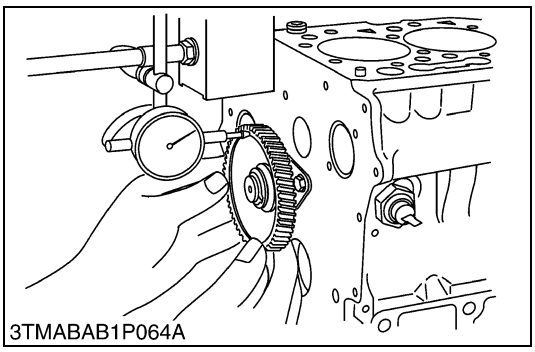
Backlash between idle gear and crank gear	Factory spec.	0.0415 to 0.1122 mm 0.00163 to 0.00442 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear and cam gear	Factory spec.	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear and injection pump gear	Factory spec.	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between crank gear and oil pump gear	Factory spec.	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.
	Allowable limit	0.15 mm 0.0059 in.

W1029564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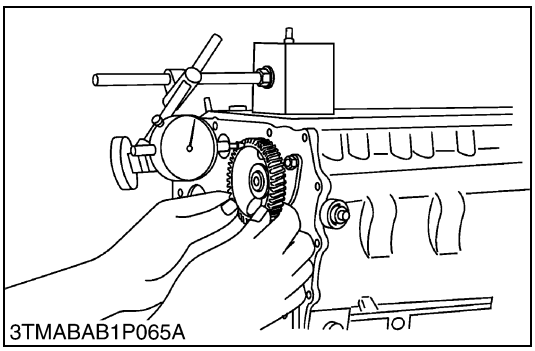
Idle Gear Side Clearance

1. Set a dial indicator with its tip on the idle gear.
2. Measure the side clearance by moving the idle gear to the front and rear.
3. If the measurement exceeds the allowable limit, replace the idle gear collar.

Idle gear side clearance	Factory spec.	0.12 to 0.48 mm 0.0047 to 0.0189 in.
	Allowable limit	0.90 mm 0.0354 in.

W1029843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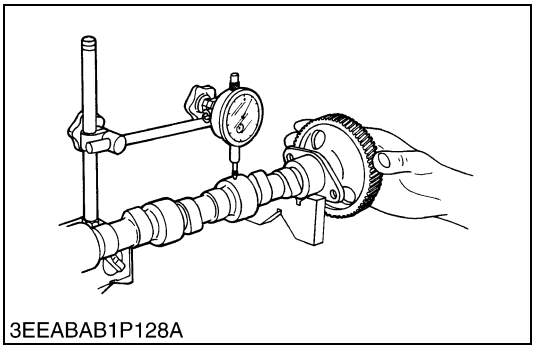
Camshaft Side Clearance

1. Set a dial indicator with its tip on the camshaft.
2. measure the side clearance by moving the cam gear to the front to rear.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper.

Camshaft side clearance	Factory spec.	0.07 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable limit	0.30 mm 0.0118 in.

W1030012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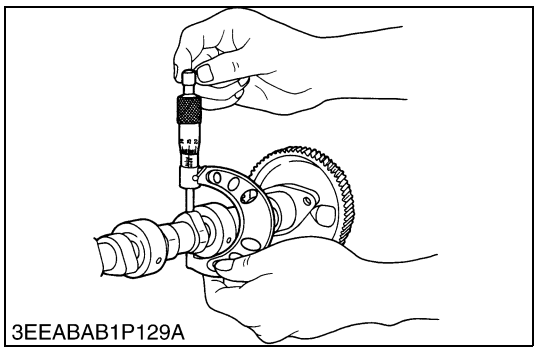
Camshaft Alignment

1. Support the camshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the camshaft alignment.
4. If the measurement exceeds the allowable limit, replace the camshaft.

Camshaft alignment	Allowable limit	0.01 mm 0.0004 in.

W1031413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Cam Height

1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

[D1403/D1503/F2803-E2B]

Cam height of intake	Factory spec.	33.263 to 33.283 mm 1.3096 to 1.3104 in.
	Allowable limit	33.22 mm 1.3079 in.
Cam height of exhaust	Factory spec.	33.463 to 33.483 mm 1.3174 to 1.3182 in.
	Allowable limit	33.42 mm 1.3157 in.

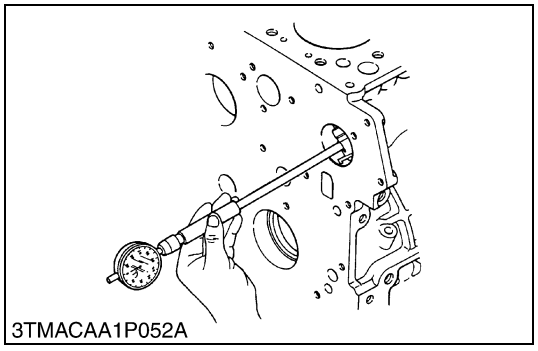
[D1703/V1903/V2203-E2B]

Cam height of intake	Factory spec.	33.463 to 33.483 mm 1.3174 to 1.3182 in.
	Allowable limit	33.42 mm 1.3157 in.
Cam height of exhaust	Factory spec.	33.463 to 33.483 mm 1.3174 to 1.3182 in.
	Allowable limit	33.42 mm 1.3157 in.

[V2003-TE2B]

Cam height of intake	Factory spec.	33.890 to 33.910 mm 1.3343 to 1.3350 in.
	Allowable limit	33.85 mm 1.3327 in.
Cam height of exhaust	Factory spec.	33.463 to 33.483 mm 1.3174 to 1.3182 in.
	Allowable limit	33.42 mm 1.3157 in.

W1031532

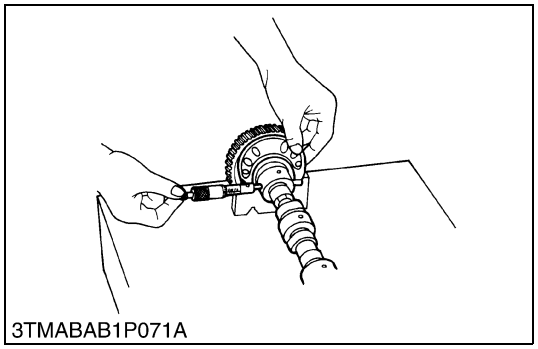

3TMACAA1P052A

Oil Clearance of Camshaft Journal

1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory spec.	0.050 to 0.091 mm 0.00197 to 0.00358 in.
	Allowable limit	0.15 mm 0.0059 in.
Camshaft journal O.D.	Factory spec.	39.934 to 39.950 mm 1.57221 to 1.57284 in.
Cylinder block bore I.D.	Factory spec.	40.000 to 40.025 mm 1.57480 to 1.57579 in.

W10299330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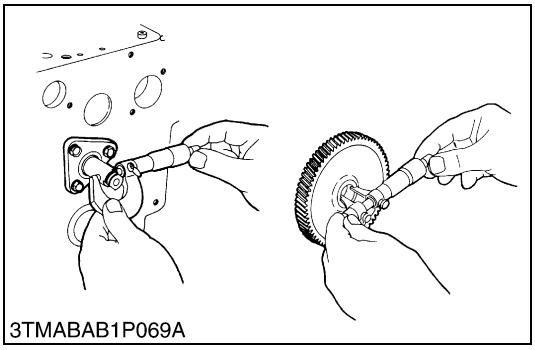

3TMABAB1P069A

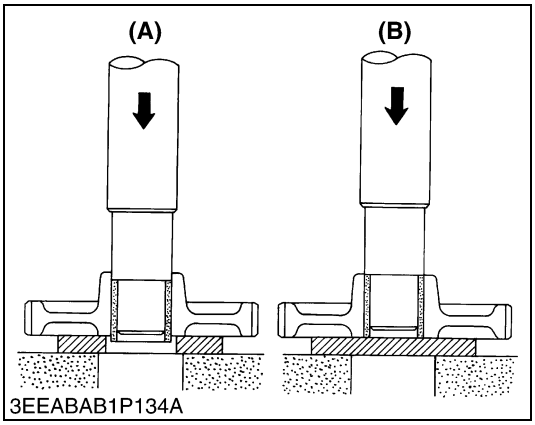
Oil Clearance between Idle Gear Shaft and Idle Gear Bushing

1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing.
   If it still exceeds the allowable limit, replace the idle gear shaft.

Oil clearance between idle gear shaft and idle gear bushing	Factory spec.	0.025 to 0.066 mm 0.00098 to 0.00260 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear shaft O.D.	Factory spec.	37.959 to 37.975 mm 1.49445 to 1.49508 in.
Idle gear bushing I.D.	Factory spec.	38.000 to 38.025 mm 1.49606 to 1.49705 in.

W1030933



3EEABAB1P134A

Replacing Idle Gear Bushing

(When removing)

1. Press out the used idle gear bushing using an idle gear bushing replacing tool. (See page **"SPECIAL TOOLS"**.)

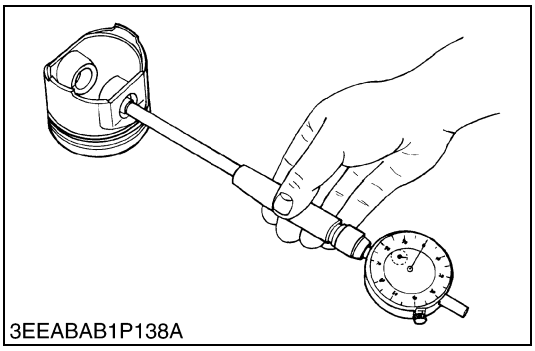
(When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Press in a new bushing using an idle gear bushing replacing tool, until it is flush with the end of the idle gear.

(A) When Removing **(B) When Installing**

W1031083

(3) Piston and Connecting Rod

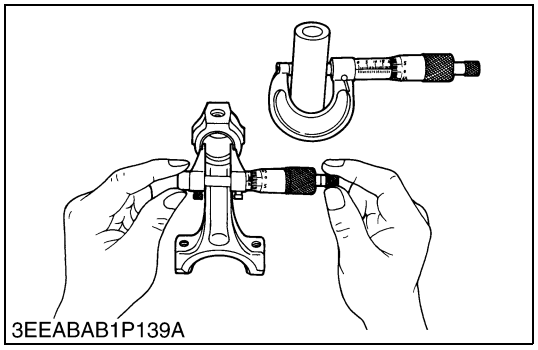

3EEABAB1P138A

Piston Pin Bore I.D.

1. Measure the piston pin bore I.D. in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

Piston pin bore I.D.	Factory spec.	25.000 to 25.013 mm 0.98425 to 0.98476 in.
	Allowable limit	25.05 mm 0.9862 in.

W1031817


3EEABAB1P139A

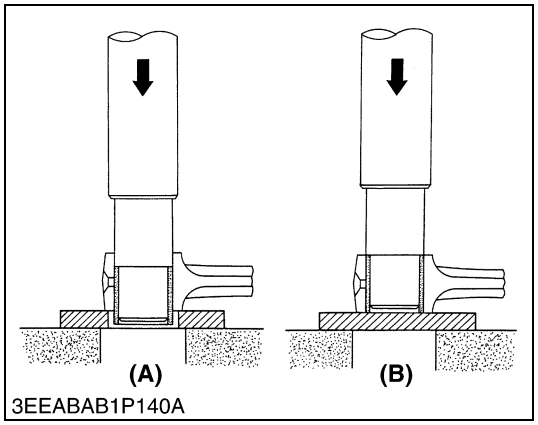
Oil Clearance between Piston Pin and Small End Bushing

1. Measure the piston pin O.D. where it contacts the bushing with an outside micrometer.
2. Measure the small end bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory spec.	0.014 to 0.038 mm 0.00055 to 0.00150 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory spec.	25.002 to 25.011 mm 0.98433 to 0.98469 in.
Small end bushing I.D.	Factory spec.	25.025 to 25.040 mm 0.98524 to 0.98583 in.

W1031982



3EEABAB1P140A

Replacing Connecting Rod Small End Bushing

(When removing)

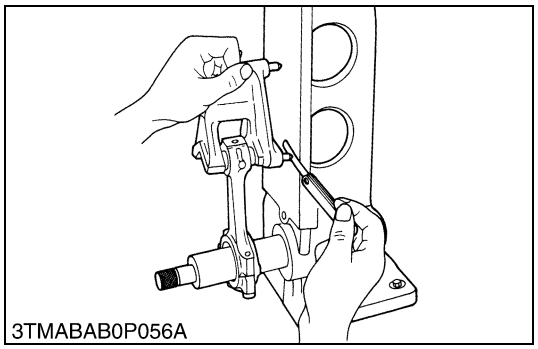
1. Press out the used small end bushing using a small end bushing replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Using a small end bushing replacing tool, press in a new bushing taking due care to see that the position of the connecting rod oil hole matches the bushing hole.

(A) When removing **(B) When installing**

W1032140


3TMABAB0P056A

Connecting Rod Alignment

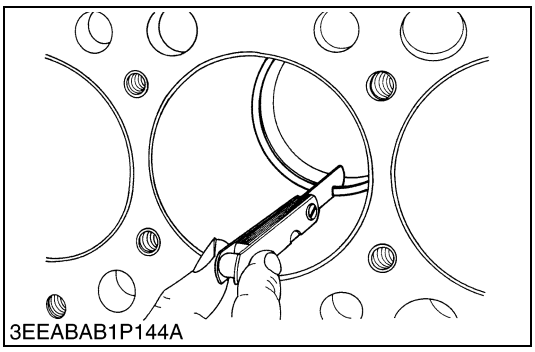
■ **NOTE**

- **Since the I.D. of the connecting rod small end bushing is the basis of this check, check bushing for wear beforehand.**

1. Install the piston pin into the connecting rod.
2. Install the connecting rod on the connecting rod alignment tool.
3. Put a gauge over the piston pin, and move it against the face plate.
4. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
5. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.0020 in.

W10314620

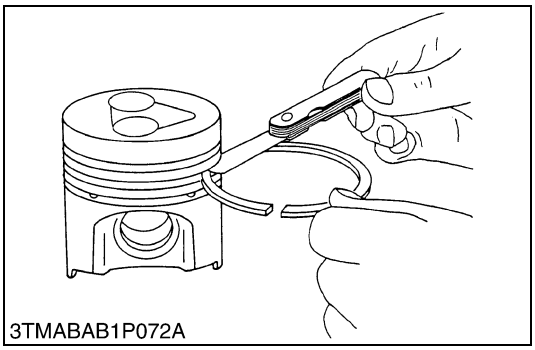

3EEABAB1P144A

Piston Ring Gap

1. Insert the piston ring into the lower part of the liner (the least worn out part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the ring.

Top ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.
Second ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.
Oil ring	Factory spec.	0.25 to 0.45 mm 0.0098 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

W1032246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Clearance between Piston Ring and Groove

1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds the allowable limit, replace the piston ring.
4. If the clearance still exceeds the allowable limit with new ring, replace the piston.

[D1403/D1503/D1703/V1903/V2203/F2803-E2B]

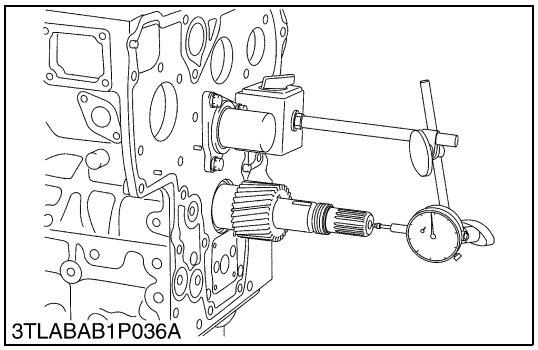
Second ring	Factory spec.	0.093 to 0.120 mm 0.0037 to 0.0047 in.
	Allowable limit	0.20 mm 0.0079 in.
Oil ring	Factory spec.	0.020 to 0.052 mm 0.0008 to 0.0020 in.
	Allowable limit	0.15 mm 0.0059 in.

[V2003-TE2B]

Second ring	Factory spec.	0.093 to 0.123 mm 0.0037 to 0.0048 in.
	Allowable limit	0.20 mm 0.0079 in.
Oil ring	Factory spec.	0.020 to 0.052 mm 0.0008 to 0.0020 in.
	Allowable limit	0.15 mm 0.0059 in.

W1032489

(4) Crankshaft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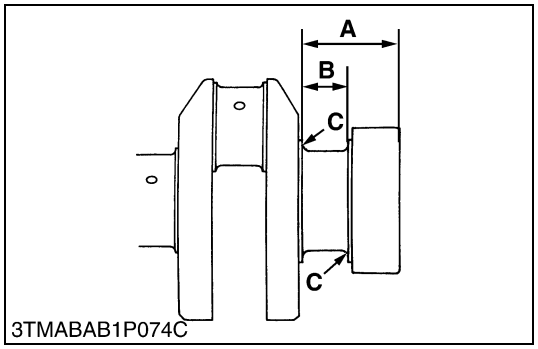

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Side Clearance of Crankshaft

1. Set a dial indicator with its tip on the end of the crankshaft.
2. Measure the side clearance by moving the crankshaft to the front and rear.
3. If the measurement exceeds the allowable limit, replace the thrust bearings.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an oversize one referring to the table and figure.

[D1403/D1503/D1703/V1903/V2003-T/V2203-E2B]

Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.50 mm 0.0197 in.

[F2803-E2B]

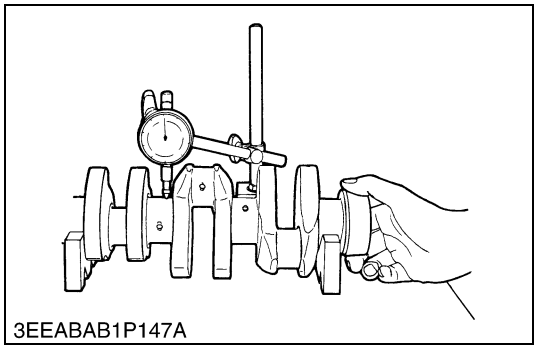
Crankshaft side clearance	Factory spec.	0.15 to 0.35 mm 0.0059 to 0.0122 in.
	Allowable limit	0.50 mm 0.0197 in.

(Reference)

- Oversize dimensions of crankshaft journal

Oversize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	54.5 to 54.7 mm 2.1457 to 2.1535 in.	54.6 to 54.8 mm 2.1496 to 2.1574 in.
Dimension **B**	26.20 to 26.25 mm 1.0315 to 1.0335 in.	26.40 to 26.45 mm 1.0394 to 1.0413 in.
Dimension **C**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
The crankshaft journal must be fine-finished to higher than ∇∇∇∇.		(0.8S)

W1032880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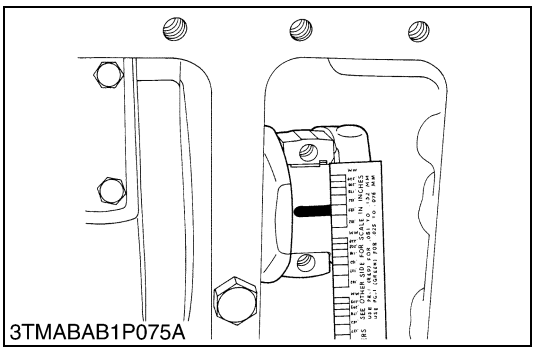
Crankshaft Alignment

1. Support the crankshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the crankshaft alignment.
4. If the measurement exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.00079 in.

W1033001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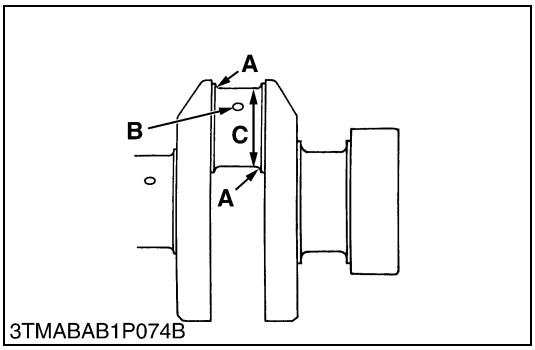


3TMABAB1P074B

Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
5. If the oil clearance exceeds the allowable limit, replace the crankpin bearing.
6. If the same size bearing is useless because of the crankpin wear, replace it with an undersize one referring to the table and figure.

■ **NOTE**

- **Never insert the plastigage into the crankpin oil hole.**
- **Be sure not to move the crankshaft while the connecting rod screws are tightened.**

Oil clearance between crankpin and crankpin bearing	Factory spec.	0.025 to 0.087 mm 0.00098 to 0.00343 in.
	Allowable limit	0.20 mm 0.0079 in.

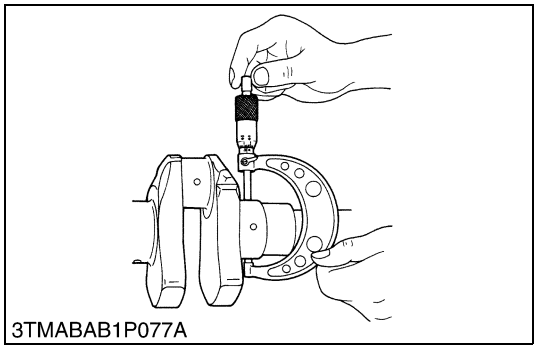
Crankpin O.D.	Factory spec.	46.959 to 46.975 mm 1.84878 to 1.84941 in.
Crankpin bearing I.D.	Factory spec.	47.000 to 47.046 mm 1.85039 to 1.85221 in.

(Reference)

- Undersize dimensions of crankpin

Undersize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	3.3 to 3.7 mm radius 0.1299 to 0.1457 in. radius	3.3 to 3.7 mm radius 0.1299 to 0.1457 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	46.759 to 46.775 mm dia. 1.84091 to 1.84154 in. dia.	46.559 to 46.575 mm dia. 1.83303 to 1.83366 in. dia.
(0.8S) The crankpin must be fine-finished to higher than ∇∇∇∇. *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.		

W1033106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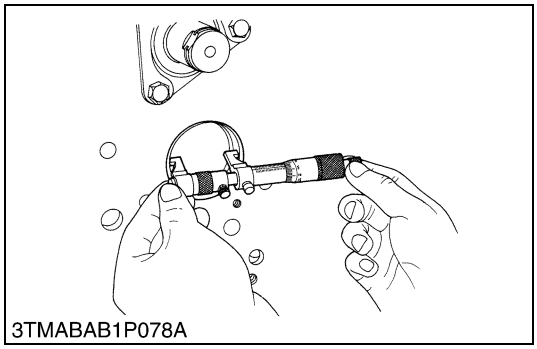
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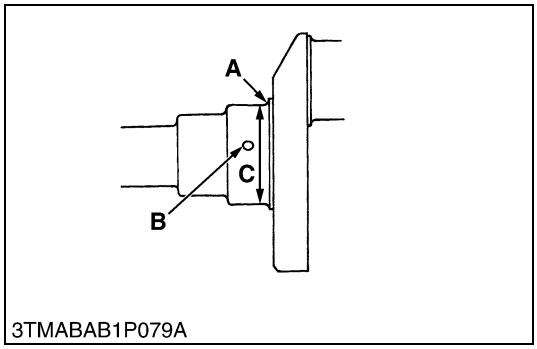

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the O.D. of the crankshaft journal with an outside micrometer.
2. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer, and calculate oil clearance.
3. If the clearance exceeds the allowable limit, replace the crankshaft bearing 1.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

Oil clearance between crankshaft journal and crankshaft bearing 1	Factory spec.	0.040 to 0.118 mm 0.00157 to 0.00465 in.
	Allowable limit	0.20 mm 0.0079 in.

[D1403/D1503/D1703/V1903/V2003-T/V2203-E2B]

Crankshaft journal O.D.	Factory spec.	59.921 to 59.940 mm 2.35910 to 2.35984 in.
Crankshaft bearing 1 I.D.	Factory spec.	59.980 to 60.039 mm 2.36142 to 2.36374 in.

[F2803-E2B]

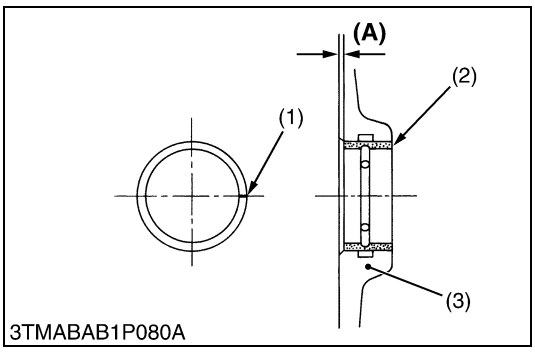
Crankshaft journal O.D.	Factory spec.	51.921 to 51.940 mm 2.04413 to 2.04488 in.
Crankshaft bearing 1 I.D.	Factory spec.	51.980 to 52.039 mm 2.04646 to 2.04878 in.

(Reference)

- Undersize dimensions of crankshaft journal

Undersize		0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**		2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*Dimension **B**		1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	D1403-E2B D1503-E2B D1703-E2B V1903-E2B V2003-TE2B V2203-E2B	59.721 to 59.740 mm dia. 2.35122 to 2.35197 in. dia.	59.521 to 59.540 mm dia. 2.34335 to 2.34410 in. dia.
	F2803-E2B	51.721 to 51.740 mm dia. 2.03626 to 2.03701 in. dia.	51.521 to 51.540 mm dia. 2.02839 to 2.02913 in. dia.
The crankshaft journal must be fine-finished to higher than ∇∇∇∇ (0.8S). *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.			

W1033717



Replacing Crankshaft Bearing 1

(When removing)

1. Press out the used crankshaft bearing 1 using a crankshaft bearing 1 replacing tool. (See page **"SPECIAL TOOLS"**.)

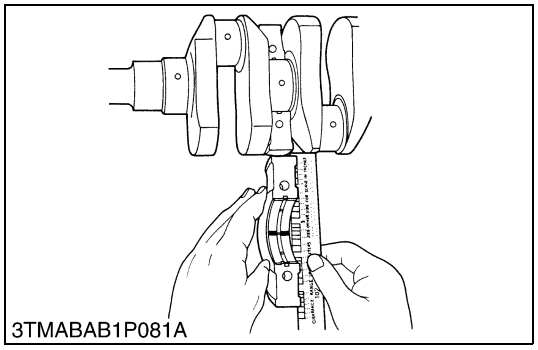
(When installing)

1. Clean a new crankshaft bearing 1 and crankshaft journal bore, and apply engine oil to them.
2. Using a crankshaft bearing 1 replacing tool, press in a new bearing 1 (2) so that its seam (1) directs toward the exhaust manifold side. (See figure.)

Dimension **(A)**	Factory spec.	4.2 to 4.5 mm 0.1654 to 0.1772 in.

(1) Seam
(2) Crankshaft Bearing 1
(3) Cylinder Block
(A) Dimension

W1033946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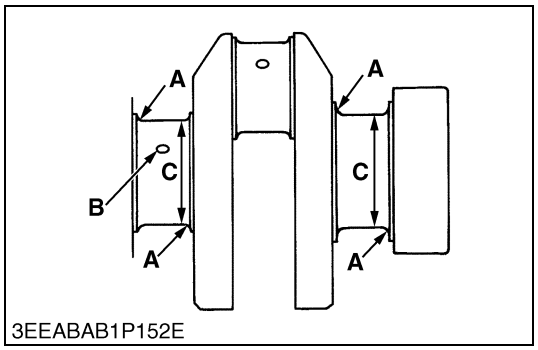

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2

1. Put a strip of plastigage on the center of the journal.
2. Install the bearing case and tighten the baring case screws 1 to the specified torque, and remove the bearing case again.
3. Measure the amount of the flattening with the scale and get the oil clearance.
4. If the clearance exceeds the allowable limit, replace the crankshaft bearing 2.
5. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

■ **NOTE**

- **Be sure not to move the crankshaft while the bearing case screws are tightened.**

Oil clearance between crankshaft and crankshaft bearing 2	Factory spec.	0.040 to 0.104 mm 0.00157 to 0.00409 in.
	Allowable limit	0.20 mm 0.0079 in.

[D1403/D1503/D1703/V1903/V2003-T/V2203-E2B]

Crankshaft journal O.D.	Factory spec.	59.921 to 59.940 mm 2.35910 to 2.35984 in.
Crankshaft bearing 2 I.D.	Factory spec.	59.980 to 60.025 mm 2.36142 to 2.36319 in.

[F2803-E2B]

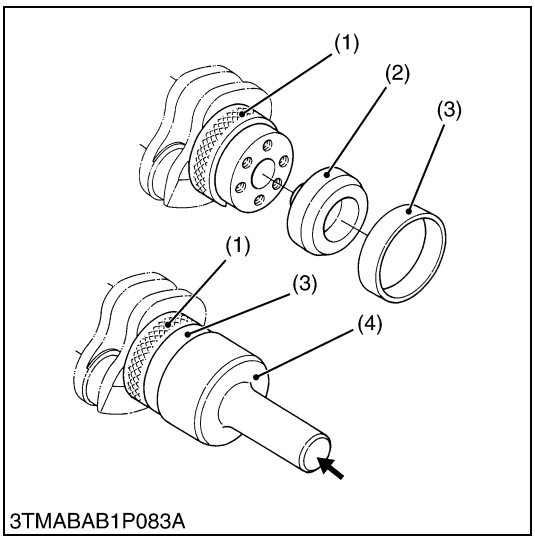
Crankshaft journal O.D.	Factory spec.	51.921 to 51.940 mm 2.04413 to 2.04488 in.
Crankshaft bearing 2 I.D.	Factory spec.	51.980 to 52.025 mm 2.04646 to 2.04823 in.

(Reference)

- Undersize dimensions of crankshaft journal

Undersize		0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**		2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*Dimension **B**		1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	D1403-E2B D1503-E2B D1703-E2B V1903-E2B V2003-TE2B V2203-E2B	59.721 to 59.740 mm dia. 2.35122 to 2.35197 in. dia.	59.521 to 59.540 mm dia. 2.34335 to 2.34410 in. dia.
	F2803-E2B	51.721 to 51.740 mm dia. 2.03626 to 2.03701 in. dia.	51.521 to 51.540 mm dia. 2.02839 to 2.02913 in. dia.
The crankshaft journal must be fine-finished to higher than ∇∇∇∇ (0.8S). *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.			

W1083821



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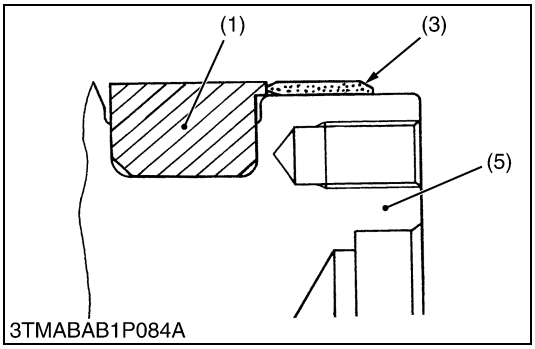

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Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve (3).
2. Set the sleeve guide (2) to the crankshaft (5).
3. Set the stopper (1) to the crankshaft (5) as shown in figure.
4. Heat a new sleeve to a temperature between 150 and 200 °C (302 and 392 °F), and fix the sleeve to the crankshaft (5) as shown in figure.
5. Press in the sleeve using the auxiliary socket for pushing (4). (Refer to **"SPECIAL TOOLS"**.)

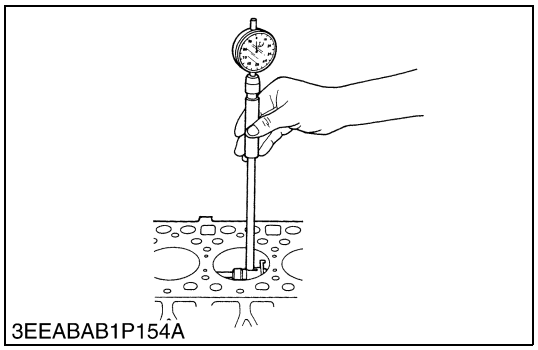
■ **NOTE**

- **Mount the sleeve with its largely chamfered surface facing outward.**
- **Should heating is not enough, a sleeve might stop halfway, so careful.**

(1) Stopper
(2) Sleeve Guide
(3) Crankshaft Sleeve
(4) Auxiliary Socket for Pushing
(5) Crankshaft

W1033503

(5) Cylinder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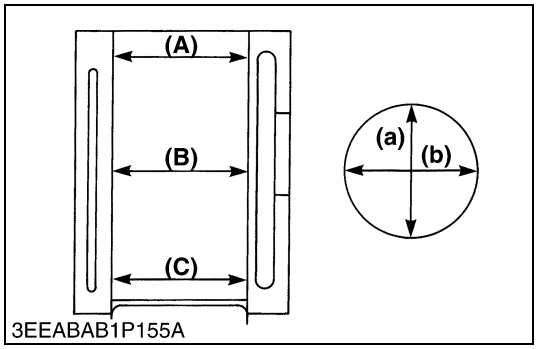

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Cylinder Wear

1. Measure the I.D. of the cylinder at the six positions (see figure) with a cylinder gauge to find the maximum and minimum I.D.'s.
2. Get the difference (Maximum wear) between the maximum and the minimum I.D.'s.
3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (Refer to **"Correcting Cylinder"**.)
4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bored. (Refer to **"Correcting Cylinder"**.)

[D1403/V1903-E2B]

Cylinder I.D.	Factory spec.	80.000 to 80.022 mm 3.14961 to 3.15047 in.
	Allowable limit	80.150 mm 3.15551 in.

[D1503/V2003-TE2B]

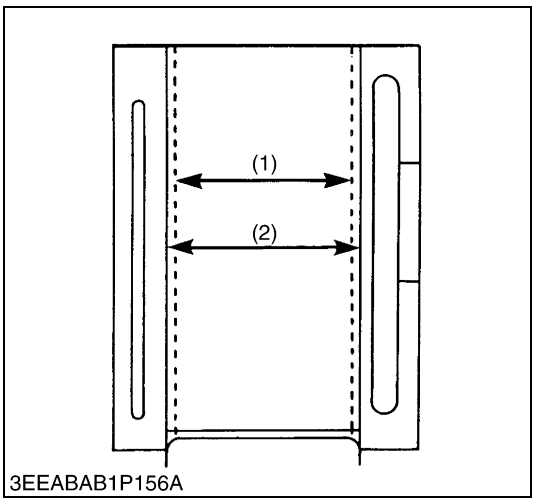
Cylinder I.D.	Factory spec.	83.000 to 83.022 mm 3.26772 to 3.26858 in.
	Allowable limit	83.150 mm 3.2736 in.

[D1703/V2203/F2803-E2B]

Cylinder I.D.	Factory spec.	87.000 to 87.022 mm 3.42520 to 3.42606 in.
	Allowable limit	87.150 mm 3.4311 in.

A: Top
B: Middle
C: Bottom (Skirt)
(a) Right-angled to Piston Pin
(b) Piston Pin Direction

W1034389



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Correcting Cylinder (Oversize)

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

[D1403/V1903-E2B]

Oversize cylinder I.D.	Factory spec.	80.500 to 80.522 mm 3.16929 to 3.17016 in.
	Allowable limit	80.650 mm 3.17520 in.

[D1503/V2003-TE2B]

Oversize cylinder I.D.	Factory spec.	83.500 to 83.522 mm 3.28740 to 3.28827 in.
	Allowable limit	83.650 mm 3.29331 in.

[D1703/V2203/F2803-E2B]

Oversize cylinder I.D.	Factory spec.	87.500 to 87.522 mm 3.44488 to 3.44575 in.
	Allowable limit	87.650 mm 3.45079 in.

Finishing	Hone to 2.2 to 3.0 μmRz (0.000087 to 0.00012 in.Rz) ∇∇∇.

2. Replace the piston and piston rings with oversize ones.
   Oversize : 0.50 mm (0.0197 in.)

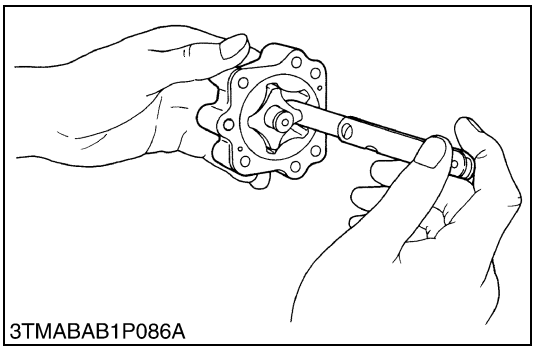
■ **NOTE**

- **When the oversize cylinder is worn beyond the allowable limit, replace the cylinder block with a new one.**

(1) Cylinder I.D. (Before Correction) (2) Cylinder I.D. (Oversize)

W1034448

(6) Oil Pump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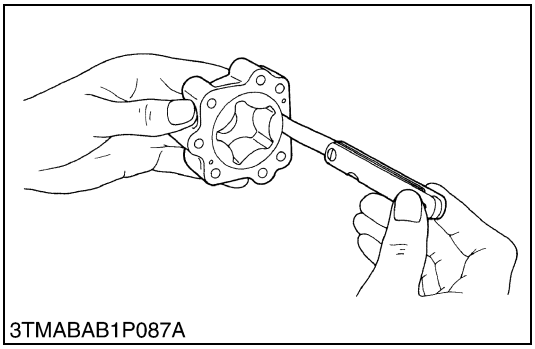
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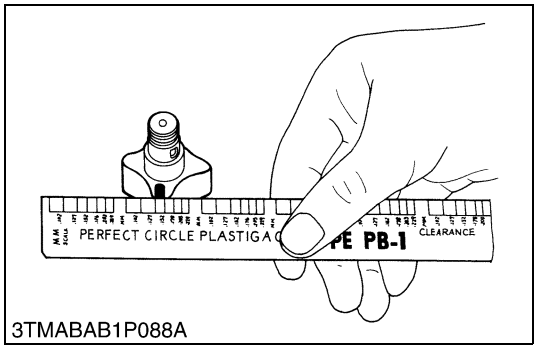
Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
3. If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory spec.	0.03 to 0.14 mm 0.0012 to 0.0055 in.
	Allowable limit	0.20 mm 0.0079 in.

Clearance between outer rotor and pump body	Factory spec.	0.11 to 0.19 mm 0.0043 to 0.0075 in.
	Allowable limit	0.25 mm 0.0098 in.

W1035296



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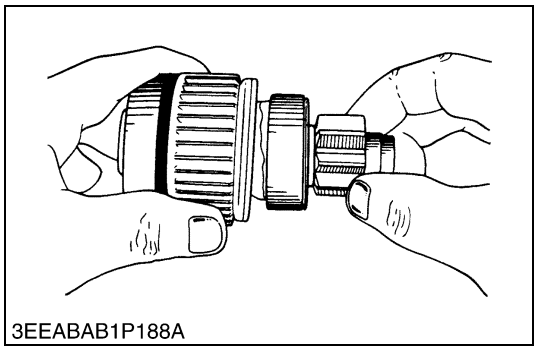
Clearance between Rotor and Cover

1. Put a strip of plastigage onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the width of the press gauge with a sheet of gauge.
4. If the clearance exceeds the factory specifications, replace oil pump rotor assembly.

Clearance between inner rotor and cover	Factory spec.	0.105 to 0.150 mm 0.00413 to 0.00591 in.
	Allowable limit	0.20 mm 0.0079 in.

W1035444

(7) Starter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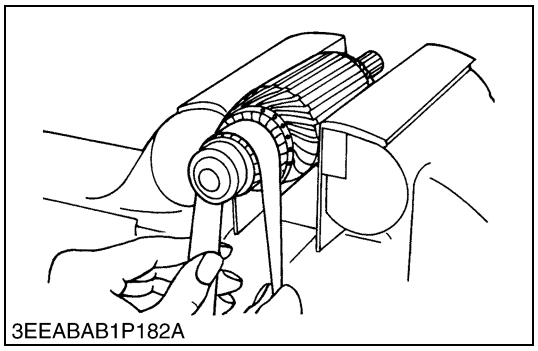
Overrunning Clutch

1. Check the pinion and if worn or damage, replace the clutch assembly.
2. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
3. If the pinion slips or does not turn in both directions, replace the overrunning clutch assembly.

■ **NOTE**

- **Do not wash off the grease in the overrunning clutch with the chemicals or oils.**

W1156799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Commutator and Mica

1. Check the contact of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

Commutator O.D.	Factory spec.	30.0 mm 1.181 in.
	Allowable limit	29.0 mm 1.142 in.

Difference of O.D.'s	Factory spec.	Less than 0.02 mm 0.0008 in.
	Allowable limit	0.05 mm 0.0020 in.

Mica under cut	Factory spec.	0.45 to 0.75 mm 0.0177 to 0.0295 in.
	Allowable limit	0.20 mm 0.0079 in.

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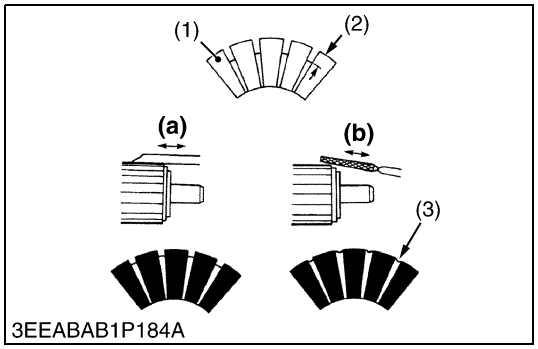

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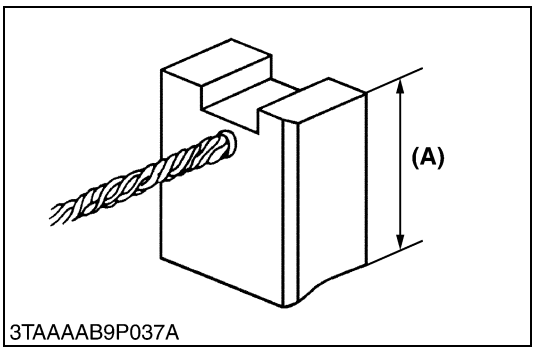
(1) Segment
(2) Depth of Mica
(3) Mica

(a) Correct
(b) Incorrect

W1155802



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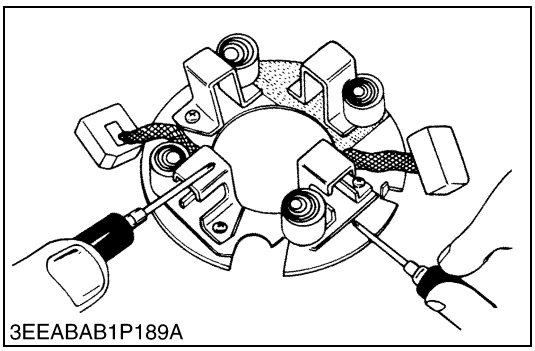
Brush Wear

1. If the contact face of the brush is dirty or dusty, clean it with emery paper.
2. Measure the brush length **(A)** with vernier caliper.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

Brush length **(A)**	Factory spec.	15.0 mm 0.591 in.
	Allowable limit	11.0 mm 0.433 in.

W1156360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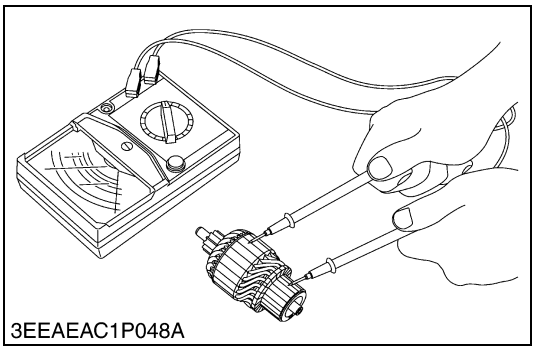
Brush Holder

1. Check the continuity across the brush holder and the holder support with a circuit tester.
2. If it conducts, replace the brush holder.

W1156895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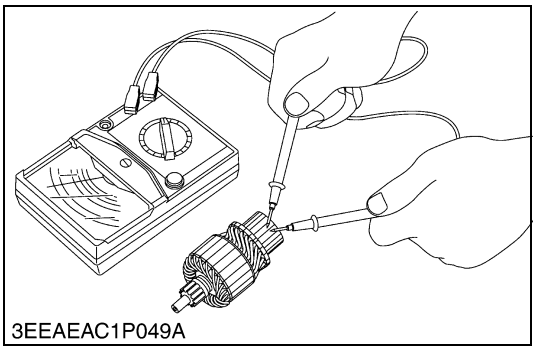
Armature Coil

1. Check the continuity across the commutator and armature coil core with resistance range of circuit tester.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with resistance range of circuit tester.
4. If it dose not conduct, replace the armature.

W1156507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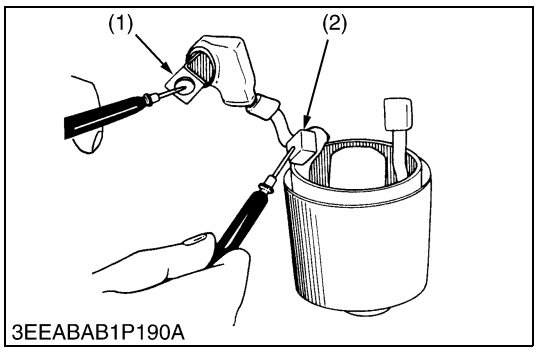

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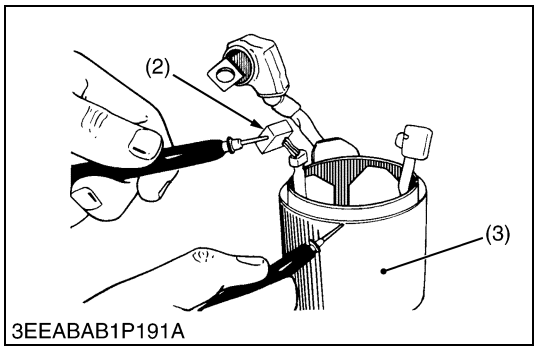

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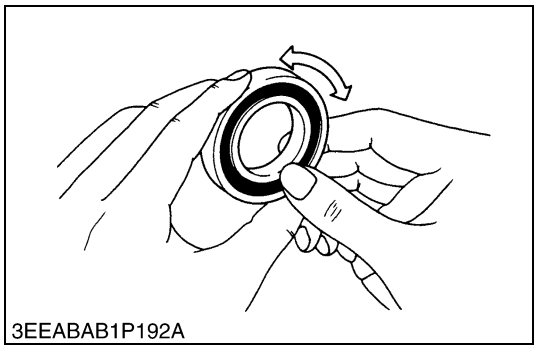
Field Coil

1. Check the continuity across the lead (1) and brush (2) with a circuit tester.
2. If it dose not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with a circuit tester.
4. If it conducts, replace the yoke assembly.

(1) Lead
(2) Bush
(3) Yoke

W1156968

(8) Alternator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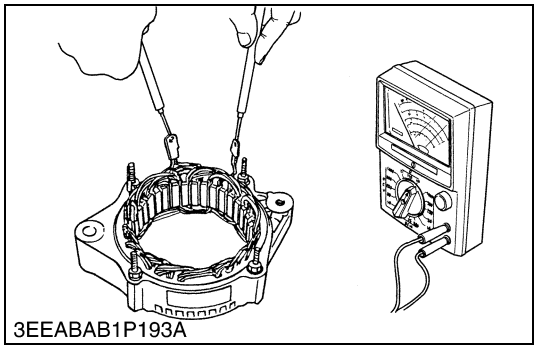
Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

W1019790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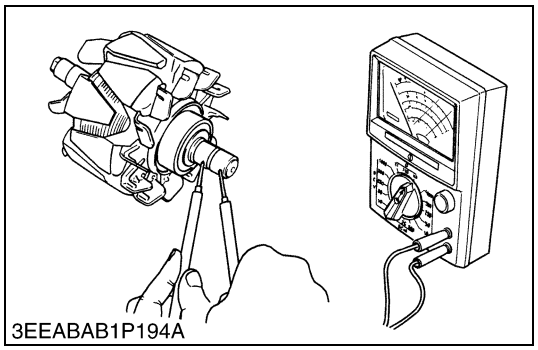
Stator

1. Measure the resistance across each lead of the stator coil with resistance range of circuit tester.
2. If the measurement is not within factory specification, replace it.
3. Check the continuity across each stator coil lead and core with resistance range of circuit tester.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	Less than 1.0 Ω

W1019964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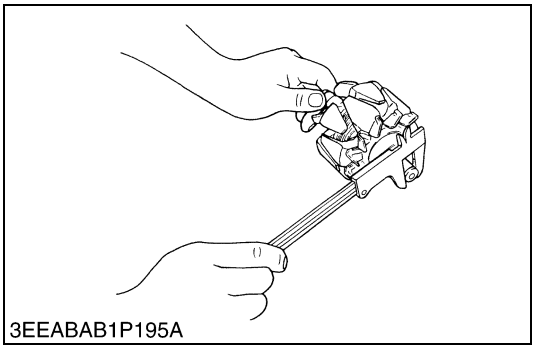
Rotor

1. Measure the resistance across the slip rings.
2. If the resistance is not the factory specification, replace it.
3. Check the continuity across the slip ring and core with resistance range of circuit tester.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	2.9 Ω

W1020094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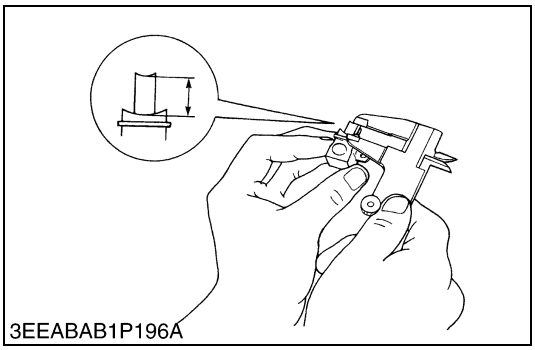
Slip Ring

1. Check the slip ring for score.
2. If scored, correct with an emery paper or on a lathe.
3. Measure the O.D. of slip ring with vernier calipers.
4. If the measurement is less than the allowable limit, replace it.

Slip ring O.D.	Factory spec.	14.4 mm 0.567 in.
	Allowable limit	14.0 mm 0.551 in.

W1020208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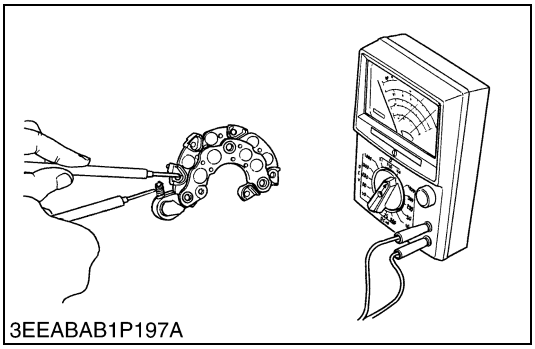
Brush Wear

1. Measure the brush length with vernier calipers.
2. If the measurement is less than allowable limit, replace it.
3. Make sure that the brush moves smoothly.
4. If the brush is defective, replace it.

Brush length	Factory spec.	10.5 mm 0.413 in.
	Allowable limit	8.4 mm 0.331 in.

W1020329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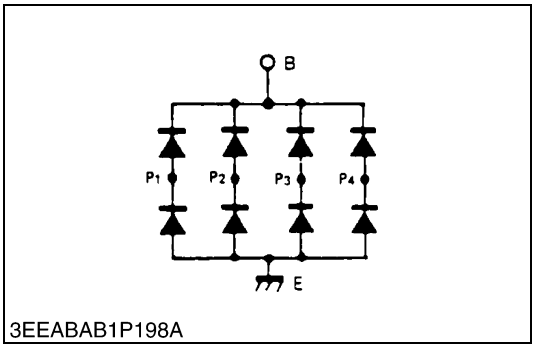
Rectifier

1. Check the continuity across each diode of rectifier with resistance range of circuit tester.
2. The rectifier is normal if the diode in the rectifier conducts in one direction and does not conduct in the reverse direction.

W1020452



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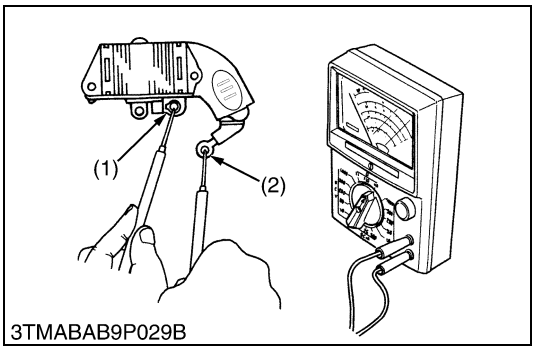
IC Regulator

1. Check the continuity across the **B** terminal (2) and the **F** terminal (1) of IC regulator with resistance range of circuit tester.
2. The IC regulator is normal if the conducts in one direction and does not conduct in the reverse direction.

(1) **F** Terminal (2) **B** Terminal

W1020645



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